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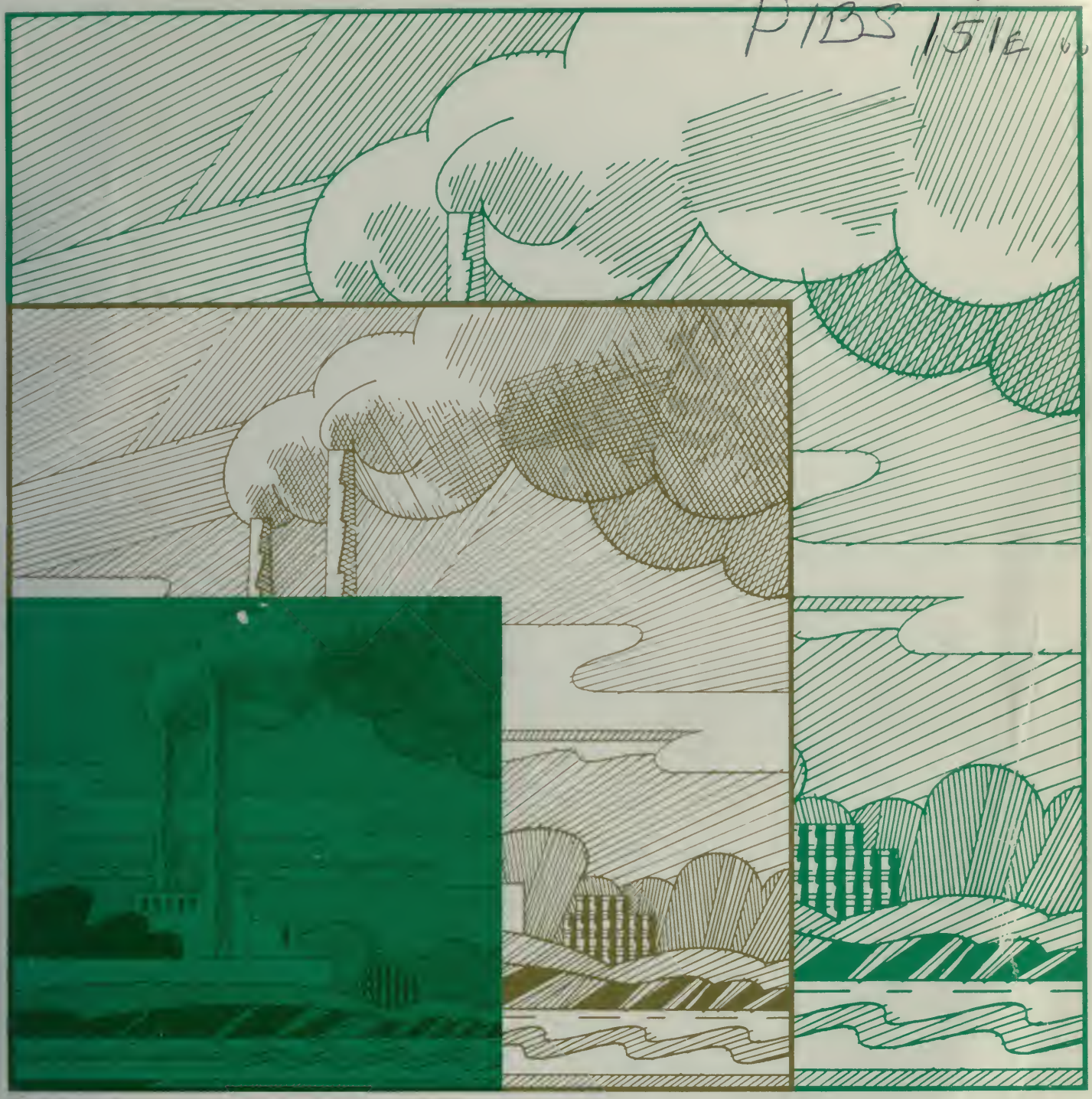
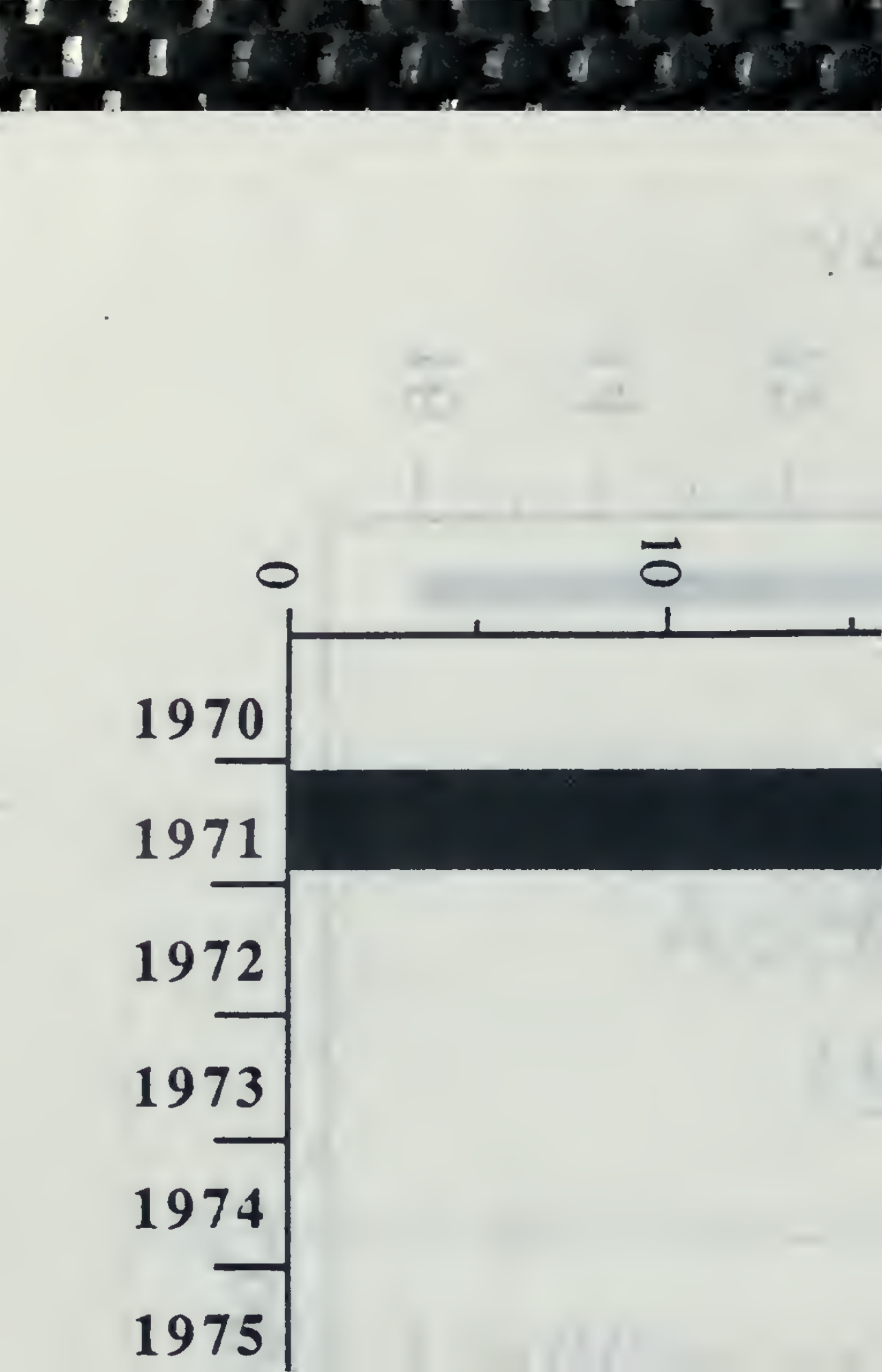


35th Ontario Waste Management Conference

June 12-15,
1988
The Prince Hotel,
Toronto, Ontario

Proceedings

Environment Ontario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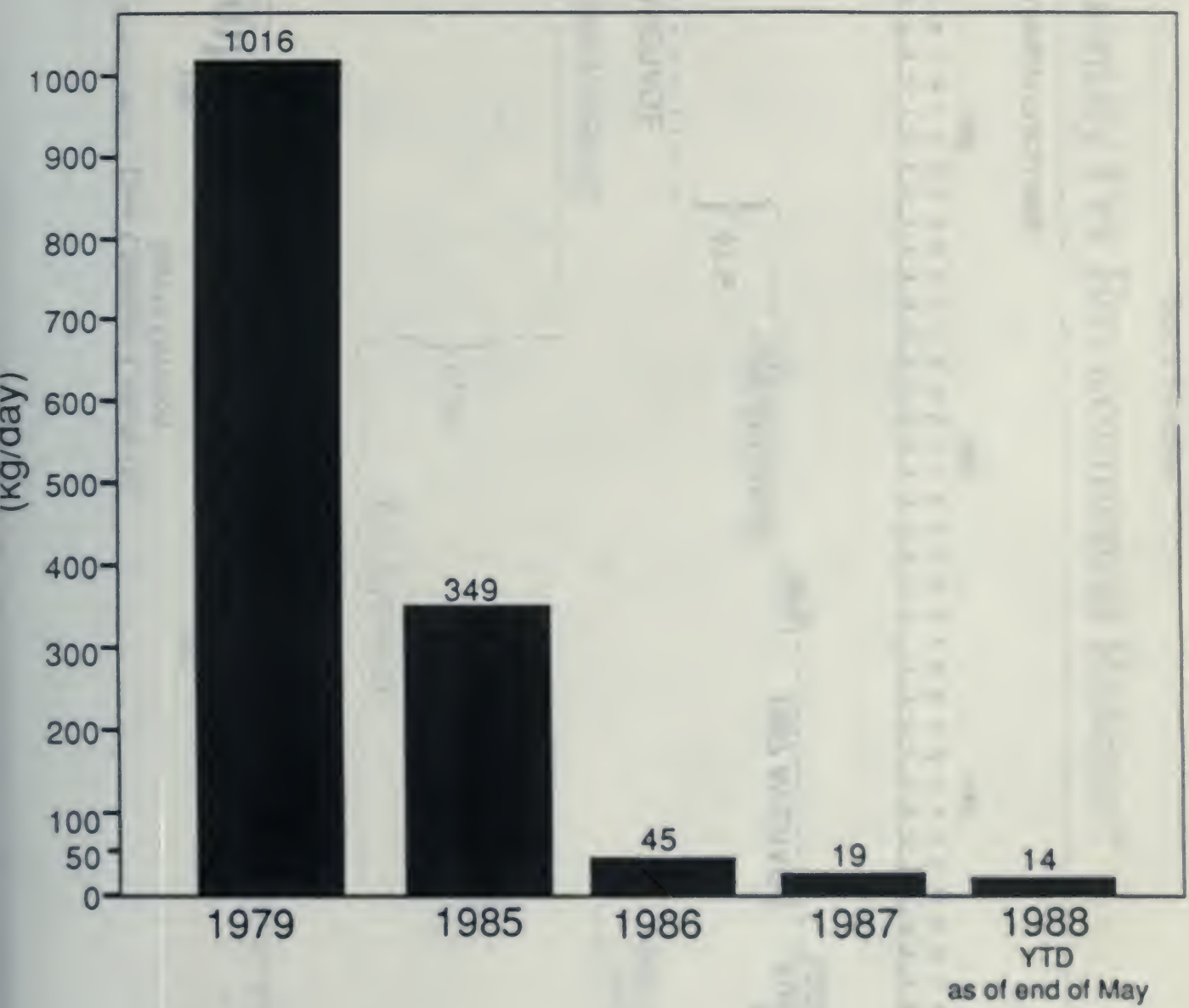
Sarnia Division

Specific Contaminants to the St. Clair River



Proceedings
of the
Thirty-fifth
Ontario Waste Management Conference

held at

The Prince Hotel
Toronto, Ontario

June 12-15, 1988

Sponsored by the
Ontario Ministry of the Environment

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PREFACE TO THE PROCEEDINGS OF THE 35th ONTARIO WASTE MANAGEMENT CONFERENCE

Perhaps because of the Conference name change, which better reflects the broader scope of the agenda, attendance was the highest in the last several years at 441. The consensus of the delegates who responded to our questionnaire was that the paper and discussion content equalled or surpassed that of previous years, much to the satisfaction of those attending.

As Chairman for the 35th Conference, I would like to thank all those who participated and attended. The calibre of papers, the presentations, and the adroit handling of sessions by the moderators, was 'first class'. The twenty papers presented by the authors covered the full gambit of environment management, with several new thoughts, ideas and technical/scientific challenges introduced for our consideration. This is what the Waste Management Conference is all about, and the Ontario Ministry of the Environment is honoured to be able to assemble such a prestigious forum for the exchange of ideas in one of the most complex fields of our profession.

I would be remiss if I did not acknowledge the planning and liaison efforts of the Conference Planning and Program Committees. Without this dedication to stage the best Conference possible for the delegates, the satisfaction dividends would not be what they are. And a special thanks to the representatives on our Program Committee from the Air Pollution Control Association and the Pollution Control Association of Ontario. It was also our pleasure to have the presidents of these two groups act as moderators, a tradition we hope to continue.

The following Proceedings are the permanent record of the 1988 Conference. Pass it around to your associates to whet their appetite to attend the 36th Ontario Waste Management Conference which will be held at the Prince Hotel in Toronto, June 11-14, 1989. Block the dates now and plan to attend.

Boris Boyko,
Chairman

ONTARIO WASTE MANAGEMENT CONFERENCE
HISTORICAL DATA

Location	Dates	Sponsor
Ontario Agriculture College, Guelph	1954 to 1956	Pollution Control Board of Ontario
Delawana Inn, Honey Harbour	1957 to 1963	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Bigwin Inn, Lake of Bays	1964 & 1965	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Park Motor Hotel, Niagara Falls	1966 & 1967	Ontario Water Resources Commission
Sheraton Brock Hotel, Niagara Falls	1968 to 1971	Ontario Water Resources Commission
Skyline Hotel, Toronto	1972 to 1974	Ontario Ministry of the Environment
The Prince Hotel, Toronto	1975 to 1988	Ontario Ministry of the Environment

Conference Chairman	Dates	Secretary/ Co-Ordinator
Dr. A.E. Berry	1954 to 1962	D.S. Caverly/M. Grove
D.S. Caverly	1963 to 1973	L.M. Tobias
K.H. Sharpe	1974 to 1976	M.J. Cathcart (1974)
D.P. Caplice	1977 & 1978	
	1975 to 1988	M.F. Cheetham
J.W. Giles	1979 to 1986	
R.M. Gotts	1987	
B.I. Boyko	1988	

Program Conveners

1954-1959 A.V. DeLaporte
1960-1973 F.A. Voege
1974-1978 J.B. Patterson
1979-1988 R.C. Stewart

1989 – 36th ONTARIO WASTE MANAGEMENT CONFERENCE
THE PRINCE HOTEL, TORONTO, ONTARIO
JUNE 11-14

CONFERENCE PLANNING COMMITTEE

Conference Chairman
B.I. Boyko
Director,
West Central Region,
Ontario Ministry of the
Environment

Conference Vice-Chairman
D. Bartkiw,
A/Director,
Waste Management Branch,
Ontario Ministry of the
Environment

Program Convener
R.C. Stewart,
Manager Technical Support,
West Central Region,
Ontario Ministry of the
Environment

Conference Co-Ordinator
M.F. Cheetham,
Co-Ordinator, Freedom of
Information and Privacy Protection,
Ontario Ministry of the
Environment

TECHNICAL PROGRAM COMMITTEE

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Environmental Approvals Branch,
Environment Ontario

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Technology and Reg. Development
Section, Air Resources Branch,
Environment Ontario

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Abatement South
Southwestern Region,
Environment Ontario, London

M. Greenfield
Dofasco, Hamilton,
for Pollution Control Association of
Ontario

P. Isles, Manager,
MISA Office, Industrial Sector,
Water Resources Branch,
Environment Ontario

A. McMillan,
Ontario Hydro, Toronto,
for Air Pollution Control
Association

G. Rocoski, Supervisor, Industrial
Program Unit, Waste Reduction
Section, Waste Management Branch,
Environment Ontario

THE PAPERS AND THE AUTHORS

at the

35th ONTARIO WASTE MANAGEMENT CONFERENCE

JUNE 1988

TORONTO, ONTARIO

Moderator: Gary S. Posen
Deputy Minister,
Environment Ontario, Toronto

Christine Hart, MPP
Parliamentary Assistant to the
Ontario Minister of the
Environment, Toronto

Dr. J.D. Pudden,
Medical Officer of Health,
County of Middlesex,
London, Ontario

David Crocker,
Legal Services Branch,
Environment Ontario, Toronto

G. Werezak, Environmental
Services, Dow Chemical Canada
Inc., Sarnia, Ontario

NEW INITIATIVES IN WASTE MANAGEMENT

by

Christine Hart, MPP,
Parliamentary Assistant to the
Ontario Minister of the Environment
Toronto

Good morning and welcome to the Ontario Waste Management Conference.

I'm standing in for Jim Bradley, who regrets he cannot be here. Jim is accompanying Premier Peterson to Montréal where they will be signing several agreements with Quebec later today.

It's a bit of a shock to realize that this event is 35 years old today. In past years we called it the Ontario Industrial Waste Conference, but that's too narrow a description for today's agenda. The name Ontario Waste Management Conference more accurately reflects our new way of thinking about waste issues.

We are learning to take a second look at our so-called garbage and see it, not merely as a disposal problem, but as a potential resource.

If mismanaged, our wastes can overwhelm our environment and, ultimately, hamper our ability to flourish as a healthy and prosperous community.

Though society has been slow to accept it, this is not a new concept. An American Indian, Chief Seattle, is on record lecturing the U.S. government on this subject back in 1854. In an eloquent speech, he displayed an understanding of environmental issues that we, with all our scientific and technical expertise, are only now beginning to grasp. "Continue to contaminate your bed," he told the new Americans, "and you will one night suffocate in your own wastes".

Our government is firmly committed to waste management options that divert wastes from disposal and put them to productive use. We are backing that commitment with financial, technical and educational support for broad-based waste management planning.

Of course, the primary responsibility for municipal waste management rests with municipal governments. It is my ministry's job to enforce environmentally sound practices and to dispense financial assistance needed by municipalities to do the job right.

We are seeking to fulfill this role by:

- Focusing on waste reduction, reuse, recycling and recovery -- the 4Rs -- as the preferred steps in managing waste.

- Requiring a much more comprehensive and careful approach to hazardous and liquid industrial waste, with full consideration of the 4Rs options and opportunities.

- Pursuing regulatory changes to encourage progressive waste management.

We are, for instance, undertaking a review of the environmental assessment process to find ways to make the process more effective and efficient for all those who take part.

Phase 1 of our review examines legislative and administrative improvements that can be made in the short term. These proposals will be released in November 1988. Phase 2, dealing with longer term improvements, will be complete in the spring of 1990.

We are further improving the EA process by developing a generic waste management alternative study for use by municipal and private sector waste facility proponents.

Using this generic study of waste management options, municipalities can determine the routes worth investigating for their communities without the expense of first-hand preliminary research. This initiative can reduce the time both municipal and private sector proponents now spend preparing for environmental assessment. We expect to have this study complete by October.

Since June of last year when our new waste management programs were announced, we have also been providing increased support for 4Rs waste management initiatives. Through our Comprehensive Funding Program, we have committed 10.5 million dollars this year to support the reduction, reuse, recycling and recovery of Ontario wastes.

This is an exponential increase from the three-quarter-of-a-million dollar funding provided for municipal recycling the year before I took office, and it symbolizes our government's commitment to ending society's one-way, throw-away mentality.

We are now fine-tuning the complete Comprehensive Funding Program to encourage all municipalities to participate in regional and county waste management plans.

Banding together under a Waste Management Master Plan creates the economies of scale that make it feasible for even the smallest of municipalities to consider 4Rs options in their long-range planning.

A considerable chunk of our resources -- 7.7 million dollars this year -- is devoted to municipal recycling, a waste management option to which this government is deeply committed.

In addition to provincial dollars, municipalities have access to private sector recycling support from the soft-drink industry and its packaging suppliers. The industry has committed itself to a four-year, twenty-million-dollar program to support new municipal recycling projects.

The funding agency, called OMMRI, Ontario Multi-Material Recycling Incorporated, was created by the industry to help it meet its obligations under the carbonated soft drink container regulation our government set out in 1985. The regulations require the soft-drink industry to ensure that 50 per cent of their non-refillable containers are being recycled by November 1988.

I congratulate these firms on the positive manner in which they have chosen to tackle the problem. The entire community benefits when industry puts its talent and resources behind environmental solutions.

The combined public and private sector funding for municipal start-up projects has spurred recycling into a growth industry in this province. We now have more than 70 municipalities involved in multi-material collection projects, with more in the works. Richmond Hill is kicking off its curbside recycling program today, for example.

More than 600,000 homes are currently serviced with curbside, multi-material collection projects.

But this is only the beginning. We are looking forward to the one-millionth Ontario householder receiving a recycling blue box this fall. We are aiming -- as an initial goal -- at a 15 per cent recycling diversion rate province-wide.

We are making progress, but we have a long way to go. We need to build upon the recycling infrastructure now being put in place around the province. I am pleased to note that this is happening.

Windsor/Essex and Guelph, for instance, are exploring the potential of composting, with funding under our municipal waste recovery program. This program offers a third of the cost for facilities to process mixed wastes and produce useful materials like compost and metals. Demonstration projects offering high-potential innovation and break-through technologies can get up to 100 per cent funding.

Taken together, recycling and full application of waste recovery, reduction and reuse have the very real potential to boost our waste diversion from landfill in Ontario to 25 per cent, and in the long term, I believe, to 50 per cent or more.

Because we are serious about achieving this 50 per cent goal, we have designed our support programs to reach beyond the municipalities. Industrial and commercial waste contributes about 50 per cent to municipal waste streams. We are eager to work with any company with good ideas on how to implement industrial 4Rs options and lighten the burden these wastes place on municipal systems.

Under a program established last year, we are prepared to pay up to half the cost of capital and commissioning expenditures, and, as with the municipal program, 100 per cent of costs for innovative and promising research and development projects.

To date we have reviewed or are in the process of reviewing over 80 projects, and we have committed funding to 33 industrial 4Rs initiatives.

In one such project, we are working with industry on developing a system to collect and recycle chloroflurocarbons used as refrigerants. This one initiative has the potential to reduce the CFC burden on the environment by thousands of tonnes annually. It supports federal and international commitments to protecting the earth's ozone layer by restricting CFC use throughout the world.

I am pleased to announce today, on behalf of Environment Minister Jim Bradley, that the ministry has re-allocated funds to more than double our support this year for industrial 4Rs projects. The number of promising proposals we are receiving requires more than the 1-point-2 million dollars already designated, so we are allocating an additional 1-point-3 million for a funding total this year of 2-point-5 million dollars.

I encourage any of of you with good ideas for waste reduction, reuse, recovery or recycling to make use of the monies available.

We are also working with the Ministry of Education to develop 4Rs materials teachers can incorporate into their school curriculum. For obvious reasons, we focus special attention on promoting recycling in the schools. Ministry staff give classroom lectures. In communities with full recycling programs, we encourage schools to take part in the process by bringing blue boxes and fine paper recycling systems into the schools.

This way kids become educated to the importance of material separation not just for household waste, but as a broad approach to waste management.

This is the kind of thinking my ministry wants to promote. We are looking to 4Rs potential for all aspects of the waste stream, including, or perhaps especially, in dealing with hazardous waste.

At the community level, programs to collect, household hazardous waste have shown success. Last year 23 municipal projects were run at a total cost of 390,000 dollars, of which the province provided some 220,000 dollars. These municipalities diverted some 1,200 waste drums from municipal disposal sites to facilities designed for such wastes. Mississauga's program was so much in demand the city set up a permanent depot for household hazardous wastes.

In other hazardous waste initiatives, we will be holding workshops to consult with the waste management industry and other stakeholders on future hazardous waste regulatory programs.

Our decisions include three major areas:

- First, developing new design and operating standards for hazardous waste management facilities,

- Second, requiring the use of the 4Rs in hazardous waste management,

- And third, ensuring that waste facilities operators provide financial assurance that the public won't be left holding the bag for cleanup and follow-up monitoring should a waste facility close down.

The result of these initiatives will be further regulatory amendments that will continue to upgrade hazardous waste management operations in this province. We want to prevent another Smithville incident from ever again occurring in this province. Costs for site cleanup, decommissioning, proper storage and destruction at the now defunct Chemical Waste Management Ltd., PCB storage facility are estimated to be in excess of twenty million dollars, all of which must be paid for from the public purse.

While we are pleased to have signed Environmental Systems Company (ENSCO) to undertake the cleanup, our government is appalled that the people of this province must foot the bill for CWML's corporate negligence. In the future, we will require that hazardous waste management companies post bonds or credit notes sufficient to cover the cost of follow-up site cleanup and monitoring.

As you know, industrial amendments to Regulation 309 were passed in September 1985. The expanded manifest system, designed to secure the fate of hazardous and liquid industrial wastes from cradle to grave, is now in full effect.

Approximately 15,000 generators of hazardous and liquid industrial waste have been registered to date under the program. In 1987, approximately 1.2 million tonnes of hazardous and liquid industrial wastes were controlled through manifests, up considerably from the 800,000 tonnes controlled in 1986.

We are pleased that industrial haulers are recognizing their reporting responsibilities under regulation 309. The increase in registration is a result of greater awareness of regulatory requirements among generators. This is due in part, I think, to the good work of our Investigations and Enforcement Branch. They are catching and convicting the few bad apples that exist in the hazardous waste hauling business.

With these initiatives, and others in the works, we are well on the way to gaining new control over our waste stream.

We are beginning to make productive use of resources that we previously incinerated or buried in landfill, we are exerting new control over the impact of hazardous wastes on our environment, and we are prolonging the life of our existing waste management facilities.

We may not yet meet the exacting standards of Chief Seattle, but I think he would be pleased with the progress we are making.

Role of Medical Officer of Health

in

Environmental Issues

by

J.D.Pudden Medical Officer of Health

Middlesex London Health Unit ,

London, Ontario

Background

There is awareness across the Province of Ontario of Environmental contamination by substances in the the air , water , and soil.In spite of legislation to promote abatement and remediation pollution in the environment,the recurring questions in communities are

1."Is health affected by the contamination of the environment?"

2."Has illness been caused by contamination of the environment ?"

3."Will there be illness in the future because of environmental contamination?"

These questions are repeatedly asked of current and former dumpsites and landfill areas, where it is readily and easily appreciated that all types of organic and inorganic substances can be detected.The potential for contact with

these substances in leachates , aquafers , and watercourses is common knowledge in communities where a dumpsite has been identified.

The impact on the health of populations around dumpsites is just beginning to be researched and understood.The effect of organic and inorganic substances with respect to specific diseases is better known in the occupational setting or after disasters where there has been a massive accidental spill.In these situations the time and duration of human exposure is measurable.As well the diseases that may occur can be defined and observed in a compliant population.On the other hand the low dose and long term exposure that dumpsites give rise to in a changing population is not easy to measure.In addition the multifactoral cause of diseases such as cancer or degenerative disease adds confusion to the understanding of the realtionship between environmental contamination and human ill health.

In the absence of definite knowledge regarding health and long term low dose exposure to the contaminants of the environment -there occurs a great deal of speculation and argument based on theories derived from animal and human exposure with extrapolation to the situations noted in communities near dumpsites.Often the speculation is polarized to opposing extremes of what the truth might be.

This is the essence of an issue.For each argument or fact that is stated in an attempt to define and deal with a problem there is an opposing argument.Rational decision making is difficult and consensus of opinion is elusive. The

forgoing description is common in communities and gives rise to "Environmental Issues".This often places municipal and provincial agencies charged with the protection of the environment and safeguarding of human health in oppostion to community groups who have fears that assurances given to them may not be valid.

Medical Officer of Health

In Ontario a Medical Officer of Health may be able to assist both communities and agencies in the understanding and resolution of Environmental Issues. Ontario has forty three Boards of Health each with a jurisdiction called a health unit.The MOH is the executive officer of the Board and the director of the programs within the health He is in a position to bring the attention of the professional staff of the Board of Health to a particular issue.An MOH is a medical doctor with specialised training and expertise in the health of populations.He is hired and employed locally by an autonomous Board of Health but his position and title are appointments given by the Minister of Health.

The MOH has several roles and attendant resources which may be brought to bear in Environmental Issues.

Legitimate Role and Authority

An MOH is required under statute to make himself aware of hazards and potential hazards to public health.He is enabled under the Health Protection and Promotion Act of Ontario to ask for and receive information with respect to any thing ,substance or condition that may pose a hazard to public health.The Ministry of the Environment and the Ministry of

Labour must reply to such requests.

An MOH is empowered to order closure, operational change and any action of abatement to reduce a hazard or potential hazard to public health.

An MOH may also be a director and provincial offences officer under Part 7 of the Environmental Protection Act of Ontario.This position enables the MOH to administer the licencing of private sewage dispaosal systems.

Resources

The MOH of a health unit jursidiction is the director of all the programs of the Board of Health in that jurisdiction.He is able to direct the resources of the Board of Health toward investigation, monitoring, or analysis of a particular situation such as health hazard .An MOH has a direct link to the Ministry of Health and may request the support of the provincial laboratories or the epidemiology services of the province.

Other Roles

Mediator: An MOH occupies a position which offers the opportunity to mediate the extremes of an environmental issue He is a scientist who can well understand the logic of the scientific position but as well can receive and identify community concerns with respect to health hazards .

An MOH may identify a middle ground which offers some resolution of an environmental issue, by acting as a liason, interface or go-beween for the scientific,and regulatory

interests on the one hand and community concerns on the other hand.

Communicator: An MOH occupies a visible public office which is responsible to the local community , but is also identified with provincial policy. Given that credibility and trust by the community are neccesary , an MOH has an opportunity to describe the respective sides of an environmental issue to the public and the government.

Interpreter:An MOH has a scientific and medical background to interpret the results of environmental testing and human health assessment.With this knowledge he can state the risk to human health with respect to environmental exposure and health effects, to the extent that health hazard and risk are known in a general population.

Advocate:The autonomy granted to an MOH requires that he have a medical opinion and a stance on environmental issues.By virtue of this autonomy and the judegement that his background and position allow, an MOH may advocate for the scientific approach to an environmental issue or he may endorse the concerns of the ccommunity.

In summary an MOH occupies a position in the community which provides an opportunity to communicate the scientific and regulatory position to the community, but as well there is an opportunity to describe the potential risks to health that

are incompletely addressed by regulation alone.

Public health , in the long run is everybody's responsibility

An MOH has some legitimate authority and a role that may facilitate that responsiblity of everybody and everyone.

Abstract of Presentation re Strict Liability - The Due Diligence Defence in Environmental cases

by
David Crocker, Legal Services
Branch, Environment Ontario

Courts hearing Environmental cases struggled for some time with the difficulty in placing the appropriate onus on the Prosecution concerning proof of the mental element of defendants and particularly defendant corporations.

In 1978 the Supreme Court of Canada handed down its decision in the appeal of a prosecution against the Corporation of the City of Sault Ste. Marie. That decision created, in Canada, the offence of strict liability and gave prospective defendants the opportunity of raising the due diligence defence now common in public welfare legislation.

Courts can now properly determine the significance of the words "cause or permit the discharge" which exist in both the Ontario Water Resources Act and the Environmental Protection Act and can properly assess the degree of control which was exercised and should have been exercised by corporations in order to try and avoid the offence which took place.

The law now clearly requires a defendant in environmental cases to prove that they took all reasonable steps to avoid the pollution, but could not avoid it. By allowing this defence the courts have clearly challenged corporations in Ontario to do everything reasonable to avoid violating environmental legislation and thereby encourage the highest standards of care.

Note: Additional comments and observations may be obtained from the author direct by contacting the Legal Services Branch of the Ontario Ministry of the Environment.

ENVIRONMENTAL PERFORMANCE - MEETING THE CHALLENGE THROUGH CONTINUOUS IMPROVEMENT

by

G. N. Werezak, Manager, Environmental Services, Dow Chemical Canada Inc., Sarnia Division, Sarnia, Ontario

GOOD MORNING. IT'S MY PLEASURE TO BE HERE WITH YOU TODAY AND DISCUSS THE MANY ASPECTS OF WASTE MANAGEMENT HERE IN ONTARIO. MY PART WILL BE TO SHOW YOU HOW WE AT DOW HAVE IMPROVED OUR ENVIRONMENTAL PERFORMANCE THROUGH A CONCEPT WE CALL THE 'CONTINUOUS IMPROVEMENT PROCESS'.

QUALITY! WHO ARGUES AGAINST QUALITY THESE DAYS? MUCH IS BEING WRITTEN AND SAID ABOUT HOW TO DEVELOP A MANAGEMENT SYSTEM TO NURTURE QUALITY IMPROVEMENT. THE CONCEPT OF QUALITY IMPROVEMENT IS VISIBLE TO US AS CONSUMERS. THE MAJOR AUTOMOBILE MANUFACTURERS ARE AMONG MANY RETAILERS APPEALING TO OUR DESIRE FOR QUALITY. THEY TELL US THAT 'QUALITY IS JOB 1' AND THAT EVEN THE SMALLEST DETAILS 'ARE SWEATED'.

TRUE QUALITY IMPROVEMENT MEANS, I BELIEVE, TO RELENTLESSLY PURSUE WAYS OF ENHANCING THE QUALITY OF EACH AND EVERY ONE OF THE ACTIVITIES WITHIN AN ORGANIZATION. NO PLATEAU OF PERFORMANCE CAN EVER BE GOOD ENOUGH. TOM PETERS, AUTHOR OF "TOWARDS EXCELLENCE", TELLS US THAT WE HAVE TO DEVELOP A PASSION FOR EXCELLENCE IN A WORLD OF CHAOS.

THIS CONCEPT OF ONGOING QUALITY IMPROVEMENT IS AN EXCITING ONE. IN DOW CANADA WE HAVE ADOPTED THE PRINCIPLE OF CONTINUOUS IMPROVEMENT TO POSITION OURSELVES TO MEET THE INCREASINGLY COMPETITIVE MARKETPLACE.

HOW DO WE DEFINE CONTINUOUS IMPROVEMENT IN DOW CANADA? WE DEFINE IT AS A CUSTOMER-ORIENTED PROCESS, A JOURNEY THAT CLOSELY EXAMINES THE WAY A JOB IS DONE AND USES BASIC DATA ANALYSIS TO IDENTIFY WAYS OF DOING THAT JOB EVEN BETTER. AT DOW, WITH THE FULL COMMITMENT OF MANAGEMENT, EACH EMPLOYEE IS BEING TRAINED AND ENCOURAGED TO ACTIVELY PARTICPATE IN FINDING NEW WAYS OF DOING THINGS BETTER IN THEIR OWN WORK AREAS. IN SHORT, WE WANT THE INVOLVEMENT OF EACH OF OUR EMPLOYEES. CONTINUOUS IMPROVEMENT IS A SIMPLE, YET VERY POWERFUL PHILOSOPHY, AS YOU WILL SEE.

THE CONTINUOUS IMPROVEMENT CONCEPT IS WIDELY APPLIED IN ALL AREAS OF OUR BUSINESS FROM R&D, ENGINEERING AND MANUFACTURING, TO COMMERCIAL AND ADMINISTRATIVE FUNCTIONS. MANAGING THIS SELF-DRIVEN CONTINUOUS IMPROVEMENT PROCESS AT EVERY LEVEL OF OUR COMPANY HAS HAD A POSITIVE IMPACT ON HOW WE PERFORM IN SUCH AREAS AS OCCUPATIONAL HEALTH AND SAFETY, CUSTOMER AND COMMUNITY RELATIONS AND, OF COURSE, ENVIRONMENTAL PERFORMANCE.

DURING THIS PRESENTATION I WANT TO SHARE WITH YOU SOME OF THE SIGNIFICANT IMPROVEMENTS WE HAVE RECORDED, USING CONTINUOUS IMPROVEMENT, RELATIVE TO ENVIRONMENTAL PERFORMANCE. I WANT TO ESPECIALLY FOCUS ON SPILL AND EMISSION REDUCTIONS AT OUR SARNIA DIVISION SITE. I WILL THEN REVIEW HIGHLIGHTS OF OUR CURRENT ACTIVITIES AND, FINALLY, I WANT TO BRIEFLY COVER SOME OF OUR PLANS FOR THE FUTURE.

BEFORE PROCEEDING, A FEW INTRODUCTORY WORDS ABOUT THE SARNIA DIVISION ARE IN ORDER. THE SITE, WHICH BEGAN OPERATIONS IN 1942, IS LOCATED ON THE ST. CLAIR RIVER WHICH CONNECTS LAKE HURON WITH LAKE ST. CLAIR. OUR DIVISION IS THE LARGEST AND MOST DIVERSIFIED CHEMICALS AND PLASTICS COMPLEX IN CANADA, CONSISTING OF 13 MANUFACTURING UNITS. WE PRODUCE ABOUT 3.4-BILLION POUNDS OF PRODUCT EACH YEAR. AMONG OUR 23 PRODUCTS ARE CHLORINE AND CAUSTIC SODA, VINYL CHLORIDE, PERCHLOROETHYLENE, EPOXY RESIN, LATEX, POLYSTYRENE AND POLYETHYLENE.

AS A KEYSTONE OF OUR OPERATIONS, WE HAVE HAD AN ENVIRONMENTAL POLICY IN PLACE FOR MANY YEARS. THIS POLICY STATES THAT: "THE DOW CHEMICAL COMPANY IS COMMITTED TO CONTINUED EXCELLENCE, LEADERSHIP AND STEWARDSHIP IN PROTECTING THE ENVIRONMENT. ENVIRONMENTAL PROTECTION IS A PRIMARY MANAGEMENT RESPONSIBILITY AS WELL AS THE RESPONSIBILITY OF EVERY DOW EMPLOYEE. IN KEEPING WITH THIS POLICY, OUR OBJECTIVE AS A COMPANY IS TO REDUCE WASTE AND ACHIEVE MINIMAL ADVERSE IMPACT ON THE AIR, WATER, AND LAND THROUGH EXCELLENCE IN ENVIRONMENTAL CONTROL."

THE POLICY HAS BASICALLY REMAINED UNCHANGED IN PRINCIPLE AS FAR BACK AS MY RECORDS SHOW. HOWEVER, IT IS REVIEWED FROM TIME TO TIME AND AT THE HEART OF A NOVEMBER 1987 REVISION IS A COMMITMENT TO DESIGN OR MODIFY PLANTS, IF NECESSARY, (QUOTE) "TO USE THE BEST PRACTICAL TECHNOLOGY TO PERMIT COMPLIANCE WITH REGULATORY REQUIREMENTS" (UNQUOTE) AND TO MINIMIZE WASTE GENERATION (QUOTE) "WITH REDUCTION AT SOURCE GIVEN FIRST CONSIDERATION"(UNQUOTE).

I SHOULD MAKE CLEAR THAT WE HAVE NOT CHANGED OUR ENVIRONMENTAL GOALS IN RECENT YEARS AS A RESPONSE TO INCREASED PUBLIC SCRUTINY AND NEW REGULATIONS. ENVIRONMENTAL RESPONSIBILITY HAS ALWAYS BEEN TAKEN SERIOUSLY AT DOW. WHAT WE HAVE DONE, THOUGH, IS TO ACCELERATE OUR EFFORTS TO IMPROVE OUR PERFORMANCE. WE HAVE INCREASED THE RATE AT WHICH WE ARE MAKING PROGRESS; AND WE HAVE MADE CONTINUOUS IMPROVEMENT AN INTEGRAL PART OF THAT ACCELERATED PACE.

AT DOW, THE PRESENT ERA OF ENVIRONMENTAL AWARENESS REALLY BEGAN IN THE LATE 60'S AND EARLY 70'S. BETWEEN 1970 AND 1985 PERSONNEL WORKING FULL TIME ON IMPROVING OUR ENVIRONMENTAL PEFORMANCE AT THE SARNIA DIVISION EXPANDED FROM ONE TO TWENTY-TWO PEOPLE. BETWEEN 1975 AND 1985 WE SPENT AN AVERAGE OF $5-MILLION EACH YEAR ON VARIOUS ENVIRONMENTAL CONTROL PROGRAMS.

THIS CHART SHOWS THE REDUCTION OF OVER 95% IN CONTAMINANTS TO THE ST. CLAIR RIVER BETWEEN 1970 AND 1985 AS MEASURED BY TOTAL ORGANIC CARBON -- THE RESULT OF THREE KEY PROGRAMS PUT IN PLACE TO SPECIFICALLY ADDRESS THIS ISSUE. WE HAVE ALSO BEEN ACTIVE IN REDUCING EMISSIONS TO THE AIR WITH AN 84% REDUCTION IN VOLATILE ORGANIC CARBON BETWEEN 1971 AND 1985 -- MATERIALS SUCH AS PROPANE, ETHYLENE AND PROPYLENE.

NOW TO THE PERIOD 1985 TO DATE. WE HAVE CONTINUED TO ADD RESOURCES TO OUR ENVIRONMENTAL PROGRAMS; FOR EXAMPLE, THERE ARE NOW 36 PEOPLE WORKING FULL TIME ON ENVIRONMENTAL ISSUES IN THE SARNIA DIVISION -- NEARLY DOUBLE THE MANPOWER LEVEL THAN IN EARLY 1985. WE HAVE ESTABLISHED AN ENVIRONMENTAL ISSUES MANAGEMENT TEAM MADE UP OF SENIOR MANAGERS FROM R&D, MANUFACTURING, COMMUNICATIONS, COMMUNITY AFFAIRS, LEGAL AND ENVIRONMENTAL SERVICES. THE TEAM, WHICH REPORTS DIRECTLY TO THE SITE MANAGER, IS MANDATED TO "IDENTIFY ENVIRONMENTAL ISSUES AND OPPORTUNITIES AND TO CHANNEL APPROPRIATE RESOURCES TO MANAGE THEM EFFECTIVELY."

EMPLOYEE AWARENESS PROGRAMS RECEIVED PRIORITY ATTENTION IN 1986/87 AND AGAIN JUST LAST WEEK. IN COOPERATION WITH THE MINISTRY OF ENVIRONMENT, OUR OPERATING BOARD MEMBERS, SENIOR MANAGEMENT FROM THE DIVISION AND OUR TECHNICAL SPECIALISTS, RESPONSIBILITY TRAINING SESSIONS OF BETWEEN 4-8 HOURS IN LENGTH WERE CONDUCTED FOR OVER 800 WORKERS FROM OPERATORS AND MAINTENANCE PEOPLE TO TOP MANAGEMENT PERSONNEL. THESE ORIGINAL SESSIONS WERE FOLLOWED BY ENVIRONMENTAL AWARENESS DAYS IN EACH EMPLOYEE'S WORK AREA, APPLYING WHAT THEY HAD LEARNED TO THEIR SPECIFIC JOBS. AS WITH HEALTH AND SAFETY, EACH EMPLOYEE WITHIN HIS WORKPLACE IS RESPONSIBLE FOR IMPROVING AND PROMOTING ENVIRONMENTAL PROTECTION -- YET ANOTHER APPLICATION OF IMPROVEMENT ON A CONTINUOUS BASIS.

SPILL REPORTING AND INVESTIGATION PROCEDURES WERE ALSO REFINED TO PRODUCE CONSISTENCY ACROSS THE PLANT SITE SO THAT LEARNING EXPERIENCES ARE NOW EXTRACTED FROM EVEN THE SMALL INCIDENTS AND SHARED THROUGHOUT THE DIVISION.

IN GENERAL, THE COMPANY'S AMBITIOUS THREE-YEAR ENVIRONMENTAL PROGRAM LAUNCHED IN EARLY 1986 FOCUSED ON POLLUTION PREVENTION AND ABATEMENT, SPILL PREVENTION AND CONTAINMENT, AND ENVIRONMENTAL MONITORING.

OVER THE LAST TWO YEARS, CAPITAL EXPENDITURES HAVE AMOUNTED TO $8.2-MILLION ON SUCH PROJECTS AS ENHANCEMENTS TO OUR WASTE WATER TREATMENT SYSTEMS, SEWER SEPARATION WORK, IMPROVED CONTAINMENT SYSTEMS AT SEVERAL OPERATING UNITS, AND BETTER WASTE MANAGEMENT AND ENVIRONMENTAL MONITORING SYSTEMS. THESE EXPENDITURES WERE PART OF A $12-MILLION SPENDING PLAN DEVELOPED BY THE COMPANY FOR THE '86-'88 PERIOD. THE ADDITIONAL $3.8-MILLION IS BEING SPENT IN 1988 ON SIMILAR PROJECTS. HERE ARE SOME EXAMPLES OF IMPROVEMENTS IN POLLUTION PREVENTION AND ABATEMENT ACHIEVED TO DATE:

* AN EXPANSION IN OUR PROCESS WATER TREATMENT FACILITY IN OUR EB/STYRENE PLANT THAT NOW TREATS ALL THE PROCESS WATER FROM THE UNIT;
* AN ECOLOGY COLUMN INSTALLED AT THE LATEX PLANT WHICH REDUCED THE ORGANICS LEVEL LEAVING THIS PLANT BY MORE THAN 99 PER CENT;
* A $1.3-MILLION UNDERGROUND BARRIER WALL BETWEEN THE RIVER AND THE PLANT SITE TO GUARD AGAINST THE POTENTIAL FOR CONTAMINANTS REACHING THE RIVER VIA GROUNDWATER;
* A VENT COLLECTION SYSTEM AT OUR STYRENE PLANT TO RECOVER HYDROGEN TO BE USED AS A FUEL. INCIDENTALLY, THIS HYDROGEN RECOVERY PROJECT TRANSLATED INTO A 40% CUT IN FUEL COSTS FOR CRACKING ETHYLBENZENE TO STYRENE -- JUST ANOTHER EXAMPLE OF HOW ENVIRONMENTAL INITIATIVES ALWAYS PAY!

PART TWO OF OUR CAPITAL PROGRAM IN THE 1986-'88 PERIOD INVOLVED REDUCING SPILL POTENTIAL. THE FOLLOWING SLIDES SHOW A NUMBER OF THESE PROJECTS:

* A FREE FLOWING WATER RESERVOIR WAS COMMISSIONED, WITH A BUILT-IN CAPABILITY TO ISOLATE PROCESS WATER FROM THE ST. CLAIR RIVER. THIS RESERVOIR IS USED CHIEFLY IN CONJUNCTION WITH CHLORINATED ORGANICS PRODUCTION;
* IN ADDITION TO CONTAINMENT FOR PROCESS WATER, WE HAVE GUARDED AGAINST SPILLS WITH THE USE OF CURBING AT THE LOADING FACILITIES OF OUR PROPYLENE OXIDE DERIVATIVES PLANT;

* CURBING IS NOW ALSO IN PLACE AROUND A PUMP STATION AT ONE OF TWO PLANTS WHERE WE PRODUCE CHLORINE, CAUSTIC AND HYDROGEN;
* WE HAVE INSTALLED MORE EMERGENCY BLOCK VALVES AT MANY OF OUR PLANTS;
* ALSO IN THE SPILL PREVENTION AND CONTAINMENT AREA, WE HAVE (AS A MATTER OF POLICY) SIGNIFICANTLY CUT OUR INVENTORIES OF CHLORINE AND SULPHUR DIOXIDE. WITH LESS MATERIAL ON SITE, THERE IS A REDUCED POTENTIAL FOR ANY LOSS TO THE ENVIRONMENT.

IN THE AREA OF ENVIRONMENTAL MONITORING, THE THIRD PART OF OUR CAPITAL SPENDING PROGRAM, WE HAVE ADDED GAS MONITORS FOR AMMONIA AND SULPHUR DIOXIDE. WE HAVE ALSO INCREASED THE NUMBER OF CHLORINE MONITORS TO A TOTAL OF 34 LOCATED BOTH ON OUR SITE AND IN A NEIGHBOURING PLANT.

THESE GAS MONITORS, PLUS OUR ON-LINE WATER SAMPLING SYSTEMS ON ALL STREAMS LEAVING THE PLANT SITE, PROVIDE US WITH THE NECESSARY EARLY WARNING SYSTEMS TO MINIMIZE THE QUANTITY OF MATERIAL LOST FROM A SPILL. IN ADDITION, WE CONDUCT ROUTINE COMPOSITE AND GRAB SAMPLES FROM OUR WATER OUTLETS ON A DAILY BASIS. WE HAVE CONSIDERABLY UPGRADED OUR LABORATORY TESTING CAPABILITY TO THE POINT WHERE WE ARE ABLE TO ANALYZE FOR OVER 40 TRACE CONTAMINANTS IN WATER AT PPB LEVELS OR LOWER. WE ARE MAINTAINING CONTINUOUS MONITORING OF OUTFALLS AND VISUALLY INSPECT THEM ON A ROUTINE BASIS.

THESE EXAMPLES ARE MORE THAN JUST A LIST OF COMPLETED PROJECTS. IN EACH CASE THEY ARE THE END PRODUCT OF SIGNIFICANT EFFORTS TO IDENTIFY OPPORTUNITIES, ASSESS AND UNDERSTAND PROBLEMS, AND APPLY SOLUTIONS. ALL ARE THE RESULT OF THE CONTIUNOUS IMPROVEMENT PROCESS, OFTEN INCORPORATING THE EFFORTS OF INTER-DEPARTMENTAL TEAMS.

THE NET RESULT OF ALL THESE INITIATIVES ARE EVIDENT IN SEVERAL AREAS. WE HAVE SEEN A REDUCTION BY MORE THAN 50% IN THE NUMBER OF ENVIRONMENTAL INCIDENTS OVER THE PAST THREE AND A HALF YEARS WITH YEAR-TO-DATE 1988 NUMBERS BASICALLY UNCHANGED FROM 1987. OVER THE PERIOD 1985 TO 1987, THE QUANTITY OF MATERIAL PER INCIDENT HAS GONE DOWN DRAMATICALLY BY MORE THAN 80 PER CENT, AS THIS SLIDE SHOWS. IN THE AREA OF QUANTITY RELEASED PER SPILL, WE HAVE SEEN A REVERSAL YEAR-TO-DATE IN 1988 DUE PRIMARILY TO TWO SPILLS IN THE FIRST QUARTER OF THE YEAR.

IN 1979 OUR DATA SHOWED SOME 1016 KG/DAY OF PRIORITY CONTAMINANTS ENTERING THE ST. CLAIR RIVER FROM OUR OPERATIONS. IN JANUARY 1986, A JOINT MOE AND ENVIRONMENT CANADA STUDY FOR 1985 SHOWED REDUCTIONS TO ABOUT 350 KG/DAY. BY THE END OF 1986 THIS FIGURE WAS DOWN TO 45 KG/DAY. TODAY, IT IS LESS THAN 10 KG/DAY.

WHERE DO WE GO FROM HERE? IN THE FUTURE WE WILL BE WORKING ON SPECIFIC PROGRAMS TO FURTHER REDUCE LEVELS OF CONTAMINANTS LEAVING THE SITE. SOME AREAS SINGLED OUT FOR PARTICULAR ATTENTION INCLUDE FURTHER SEWER SEPARATION, REDUCTION IN WATER USE AND EXPANDED USE OF WATER RECYCLING. WE HAVE IDENTIFIED, AND WILL CONTINUE TO SEEK WAYS, TO FURTHER REDUCE AIR EMISSIONS.

OUR GOAL IS TO VIRTUALLY ELIMINATE SPILLS BY THE CONTINUED IDENTIFICATION AND CORRECTION OF ANY WEAKNESSES IN OUR SYSTEMS OR PRACTISES. WE WILL IMPROVE OUR "EARLY WARNING" CAPABILITIES AND EXPAND LABORATORY ANALYSES TO DETECT SMALLER AND SMALLER QUANTITIES OF SPECIFIC POLLUTANTS IN BOTH AIR AND WATER.

OUR AIM IS ALSO TO CONTINUE REDUCTIONS OF WASTE AT THE SOURCE, EXPAND OUR GROUNDWATER PROTECTION PROGRAMS AND EVALUATE ALTERNATIVES TO LANDFILLING. WE RECENTLY ANNOUNCED A FEASIBILITY STUDY TO BUILD AND OPERATE A ROTARY KILN INCINERATOR TO BURN SITE-GENERATED CHEMICAL WASTE. AN ADVISORY PANEL IS BEING ESTABLISHED WITH A CROSS-SECTION OF COMMUNITY REPRESENTATIVES TO IDENTIFY AND ADDRESS PUBLIC QUESTIONS REGARDING THIS PROJECT.

IN RECENT YEARS, WE HAVE COME TO RECOGNIZE THE IMPORTANCE OF TWO-WAY COMMUNICATIONS WITH THE PUBLIC. AFTER ALL, CONTINUOUS IMPROVEMENT IS NOT ACCOMPLISHED IN A VACUUM. WE BELIEVE THE PUBLIC HAS A NEED TO KNOW MORE ABOUT WHAT WE DO, HOW WE OPERATE AND WHAT OUR GOALS ARE FOR IMPROVED ENVIRONMENTAL PERFORMANCE IN THE FUTURE.

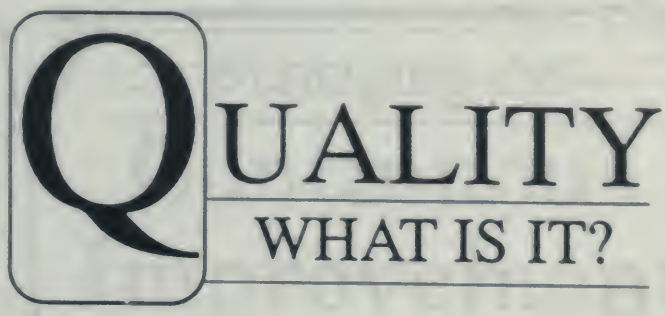
IT IS IMPORTANT TO US THAT THE PUBLIC SEES US, THROUGH OUR ACTIONS, AS OPEN, HONEST AND RESPONSIVE TO THEIR QUESTIONS. OUR DOORS ARE OPEN TO ANYONE WITH AN INTEREST IN SEEING WHAT GOES ON INSIDE OUR PLANT GATES. SINCE WE BEGAN A PUBLIC TOUR PROGRAM IN JULY 1986 SOME 3,000 PEOPLE HAVE VISITED THE SITE INCLUDING THE GENERAL PUBLIC, CIVIC OFFICIALS, THE MEDIA, ENVIRONMENTAL GROUPS, POLITICIANS AND STUDENTS.

WE HAVE ALSO PLACED A STRONG EMPHASIS ON OPENNESS WITH THE MEDIA. EVERY QUESTION IS RESPONDED TO AND EVERY ENVIRONMENTAL INCIDENT REPORTED TO THE MINISTRY OF ENVIRONMENT IS ALSO COMMUNICATED TO THE MEDIA AT THE SAME TIME AS WE REPORT TO THE M.O.E. DISCUSSIONS ARE HELD WITH THE LOCAL PRINT AND BROADCAST MEDIA ON SUCH TOPICS AS THE MEANING OF SCIENTIFIC TERMS, AND CHEMICALS USED AND PRODUCED AT DOW.

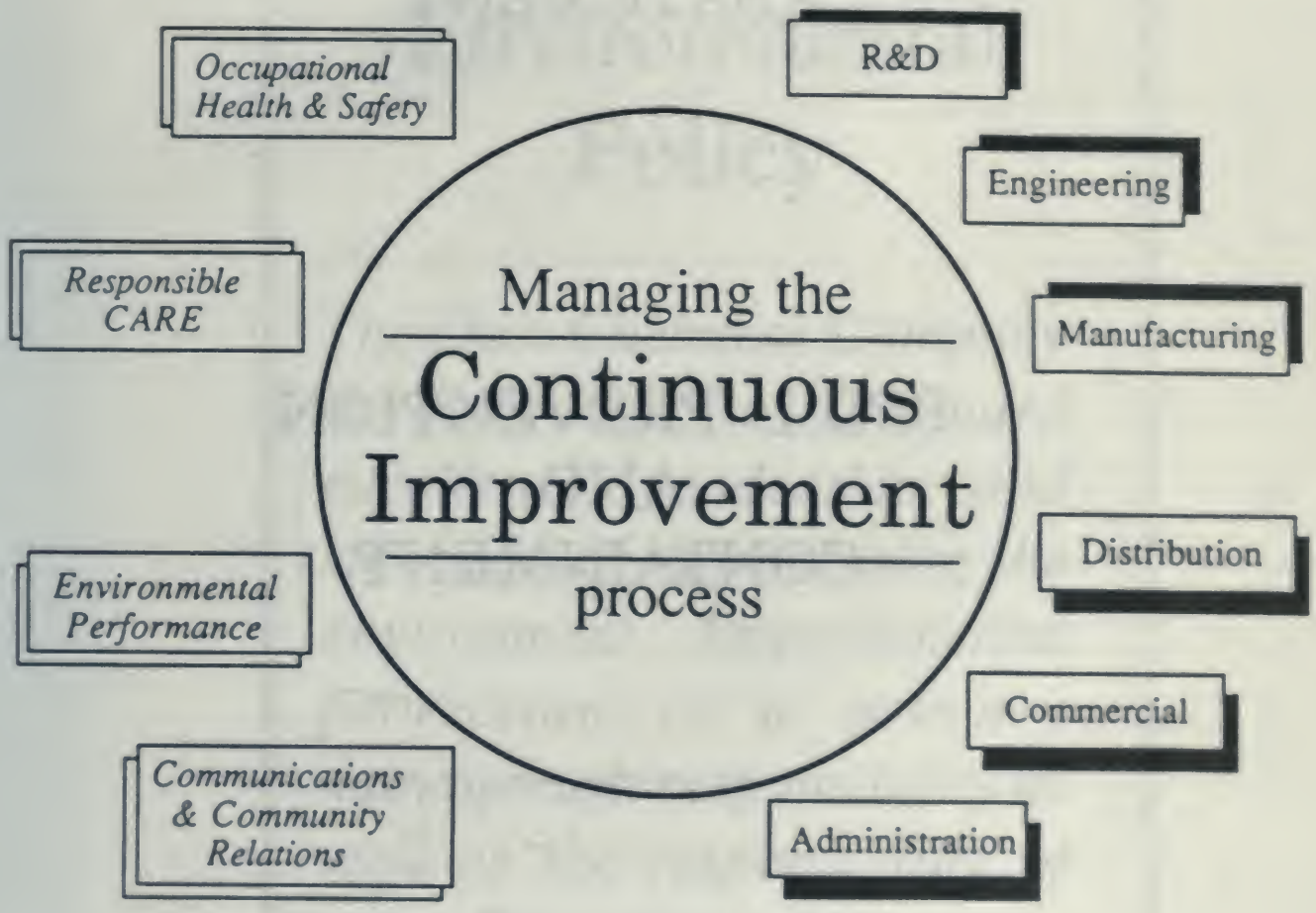
WHILE THE FUTURE HOLDS MANY CHALLENGES, WE ARE EXCITED BY WHAT WE WILL ACCOMPLISH THROUGH OUR CURRENT AND PLANNED PROGRAMS. OUR TRACK RECORD IS CONFIRMATION THAT CONTINUOUS COMMITMENT TO PROTECTING THE ENVIRONMENT PAYS SIGNIFICANT DIVIDENDS IN PERFORMANCE AND COMPANY CREDIBILITY.

THERE IS SOMETHING ELSE WE CAN BE SURE OF IN THE YEARS AHEAD. MANAGING THE CONTINUOUS IMPROVEMENT PROCESS IS A NEVER-ENDING CYCLE OF PLANNING, DESIGNING AND IMPLEMENTING CHANGES AND, FINALLY, MEASURING THE RESULTS. WE WILL REMAIN OUR OWN SEVEREST CRITICS WITH THE CONFIDENCE THAT OUR PROGRESS WILL BE RECOGNIZED.

AS THE FINAL SLIDE SHOWS, PROTECTING THE ENVIRONMENT IS A RESPONSIBILITY WE TAKE VERY SERIOUSLY.


QUALITY
WHAT IS IT?

CONTINUOUS IMPROVEMENT


Occupational Health & Safety
R&D
Engineering
Responsible CARE
Managing the
Continuous Improvement
process
Manufacturing
Distribution
Environmental Performance
Commercial
Communications & Community Relations
Administration

POLLUTION PREVENTION AND ABATEMENT

SPILL PREVENTION AND CONTAINMENT

ENVIRONMENTAL MONITORING

Environmental Policy

The Dow Chemical Company is committed to continued excellence, leadership and stewardship in protecting the environment. Environmental protection is a primary management responsibility as well as the responsibility of every Dow employee.

Environmental Policy

In keeping with this policy, our objective as a Company is to reduce waste and achieve minimal adverse impact on the air, water, and land through excellence in environmental control.

RESOURCES

* 36 people now dedicated to Environmental Programs
* Issue Management Team
* Employee Awareness Programs
* Environmental Awareness Days

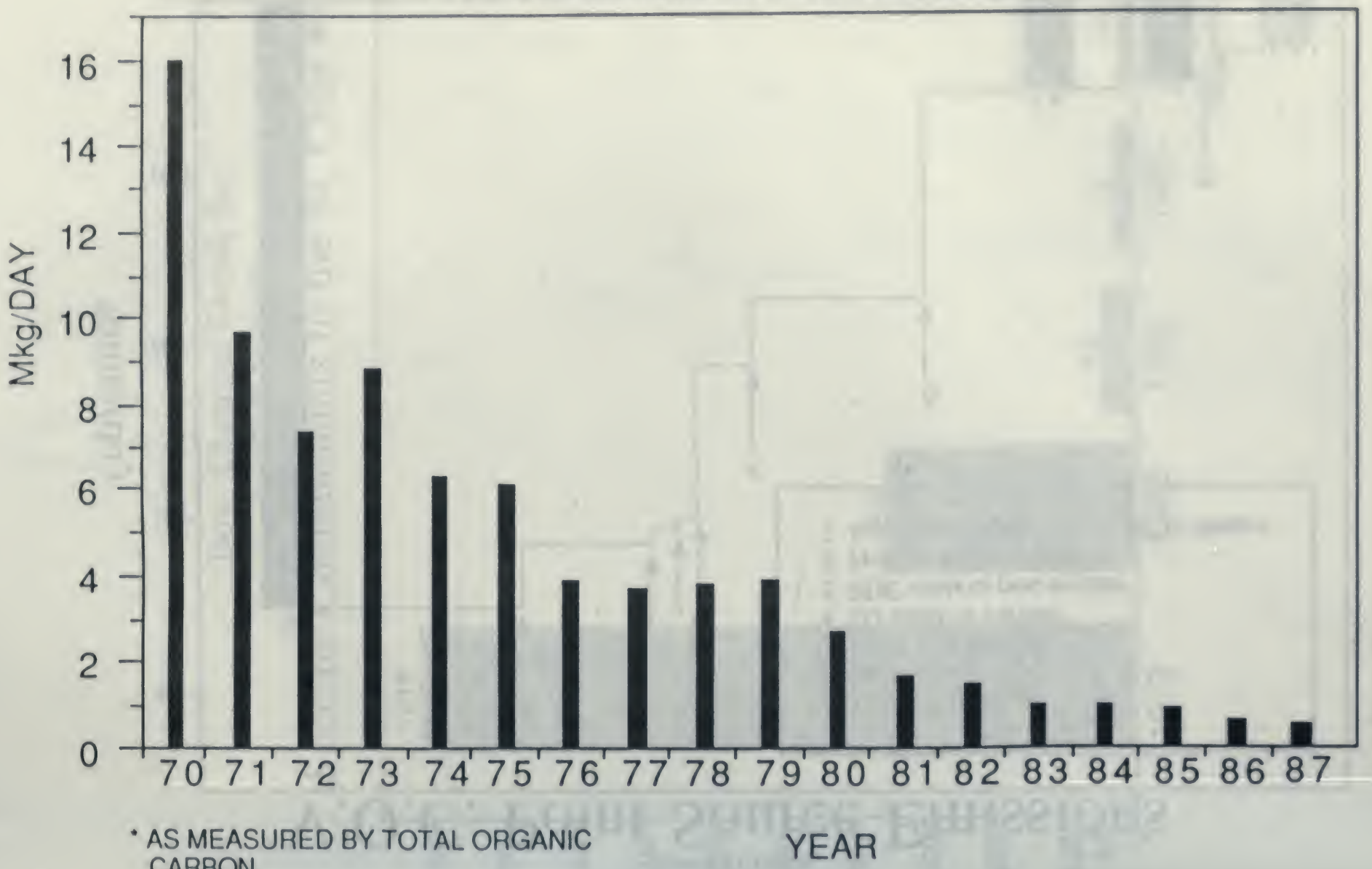
Accomplishments
1986 to date

$8.2 million expenditure to improve-

* Water purification systems
* Sewer separation work
* Containment systems
* Waste management & environmental monitoring

Dow Chemical Canada Inc.
Sarnia Division

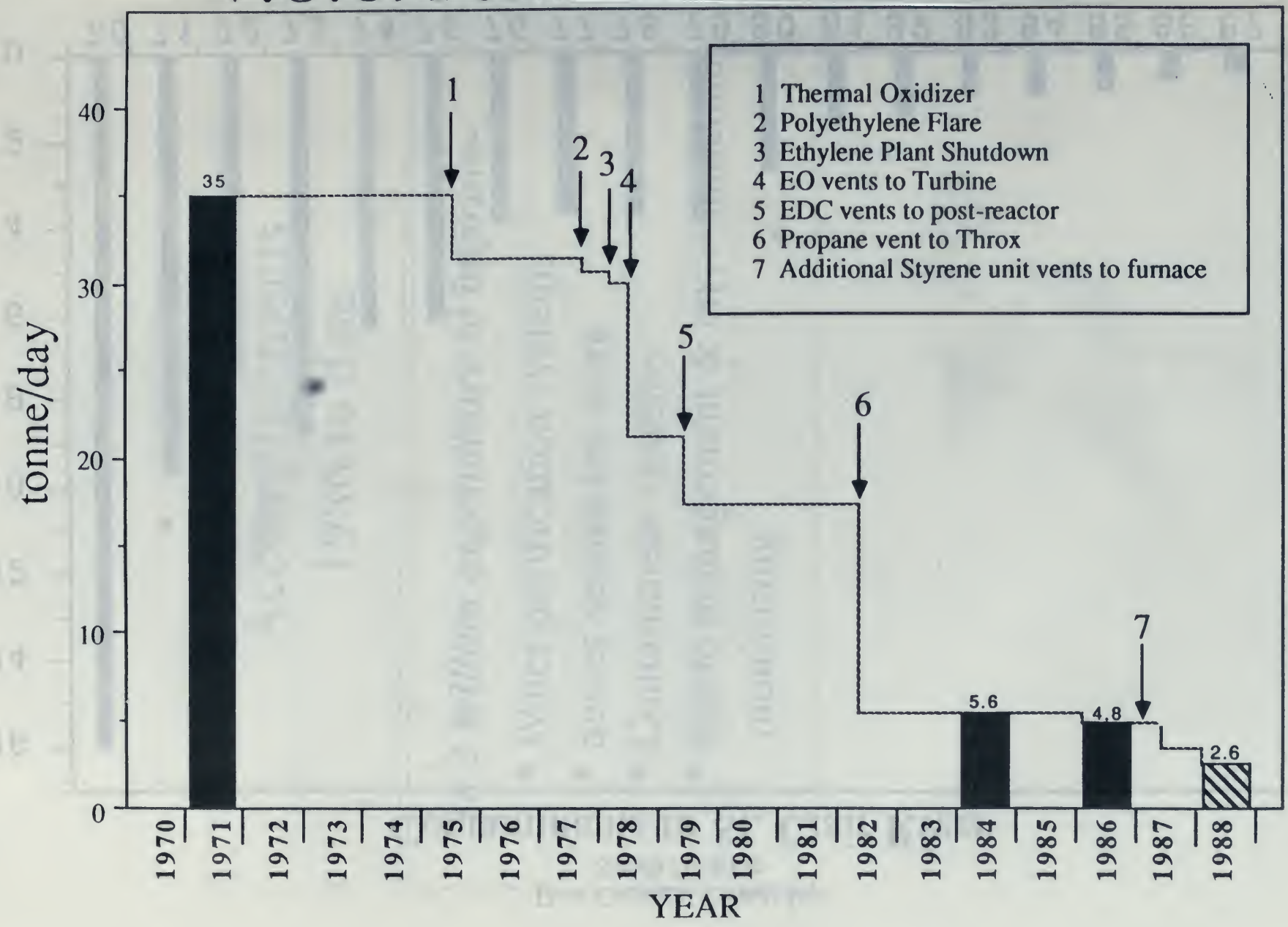
Contaminants to St. Clair River



* AS MEASURED BY TOTAL ORGANIC CARBON

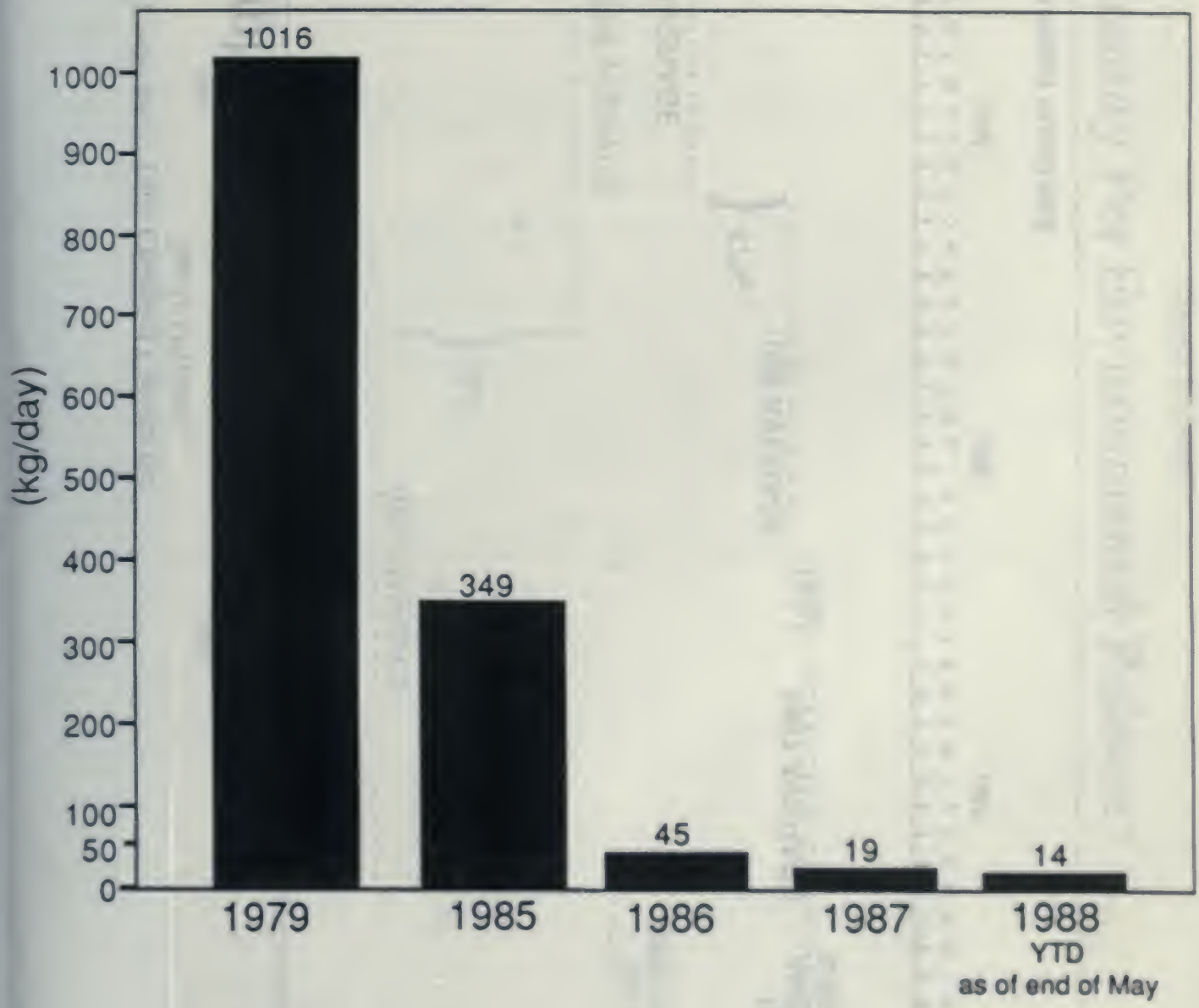
Dow Chemical Canada Inc.
Sarnia Division

V.O.C. Point Source Emissions



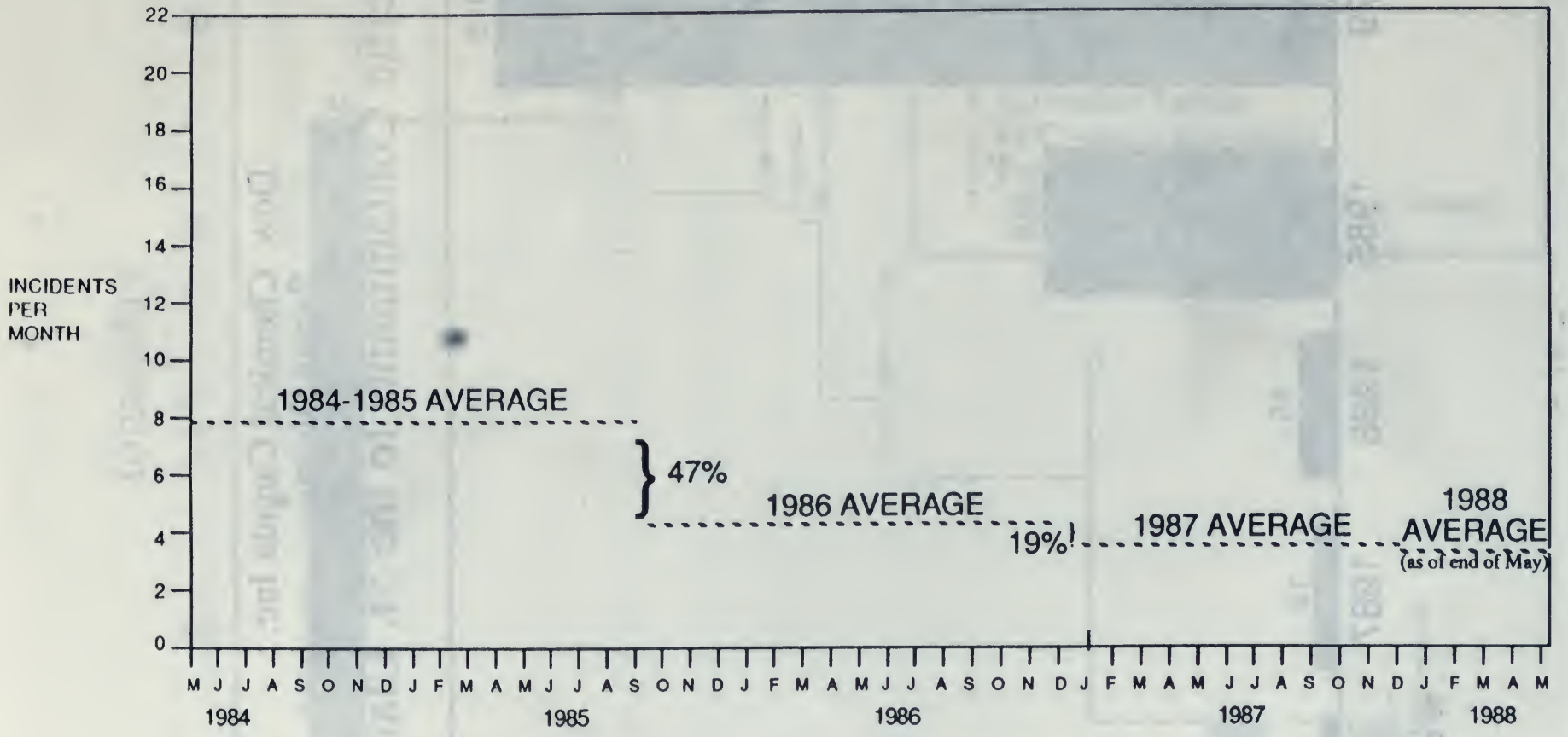
Dow Chemical Canada Inc.
Sarnia Division

Specific Contaminants to the St. Clair River



Dow Chemical Canada Inc.
Sarnia Division

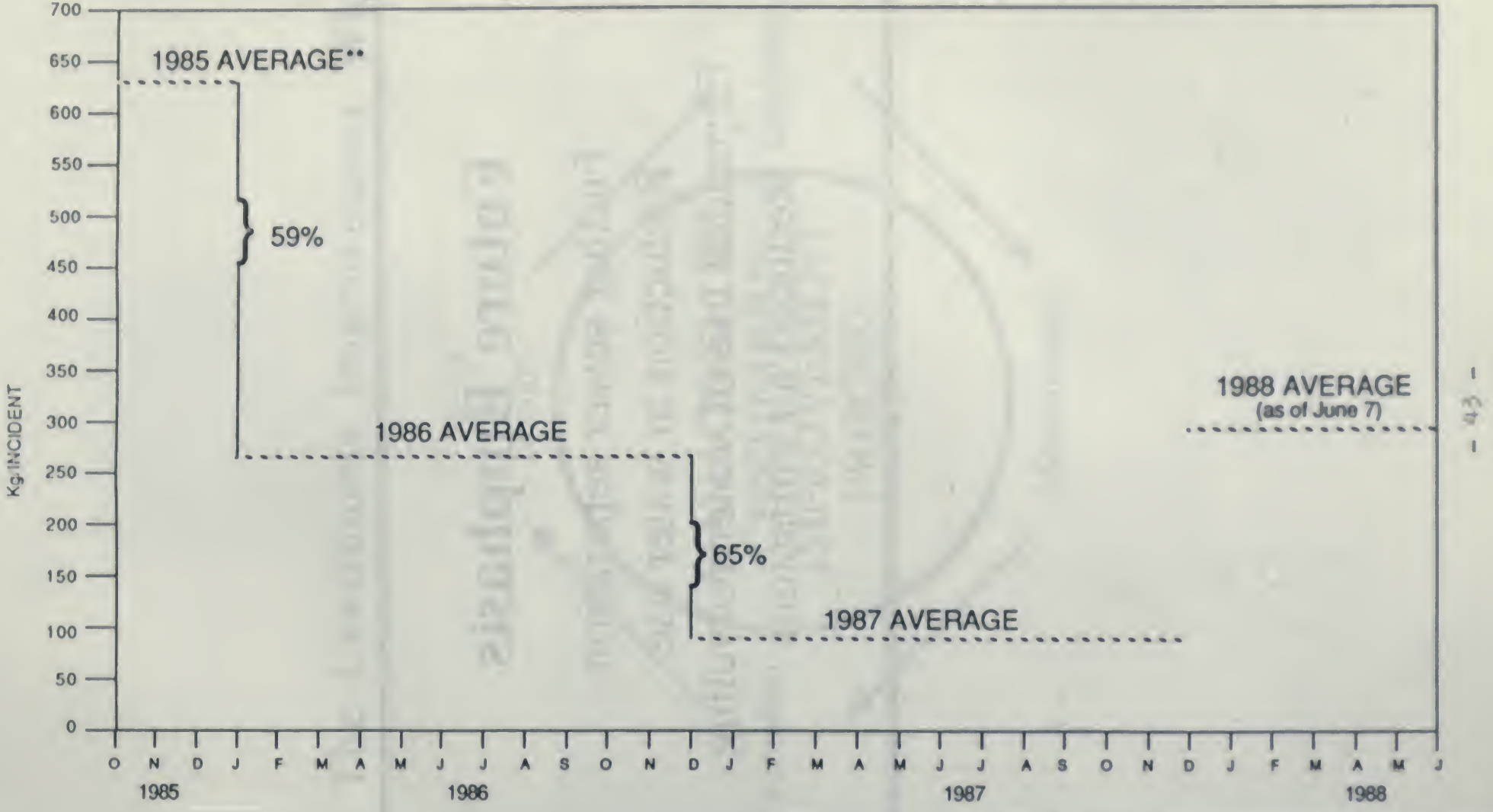
Number of Environmental Releases*



* AS MEASURED BY CURRENT GUIDELINES

Dow Chemical Canada Inc.
Sarnia Division

Quantity Per Environmental Release*

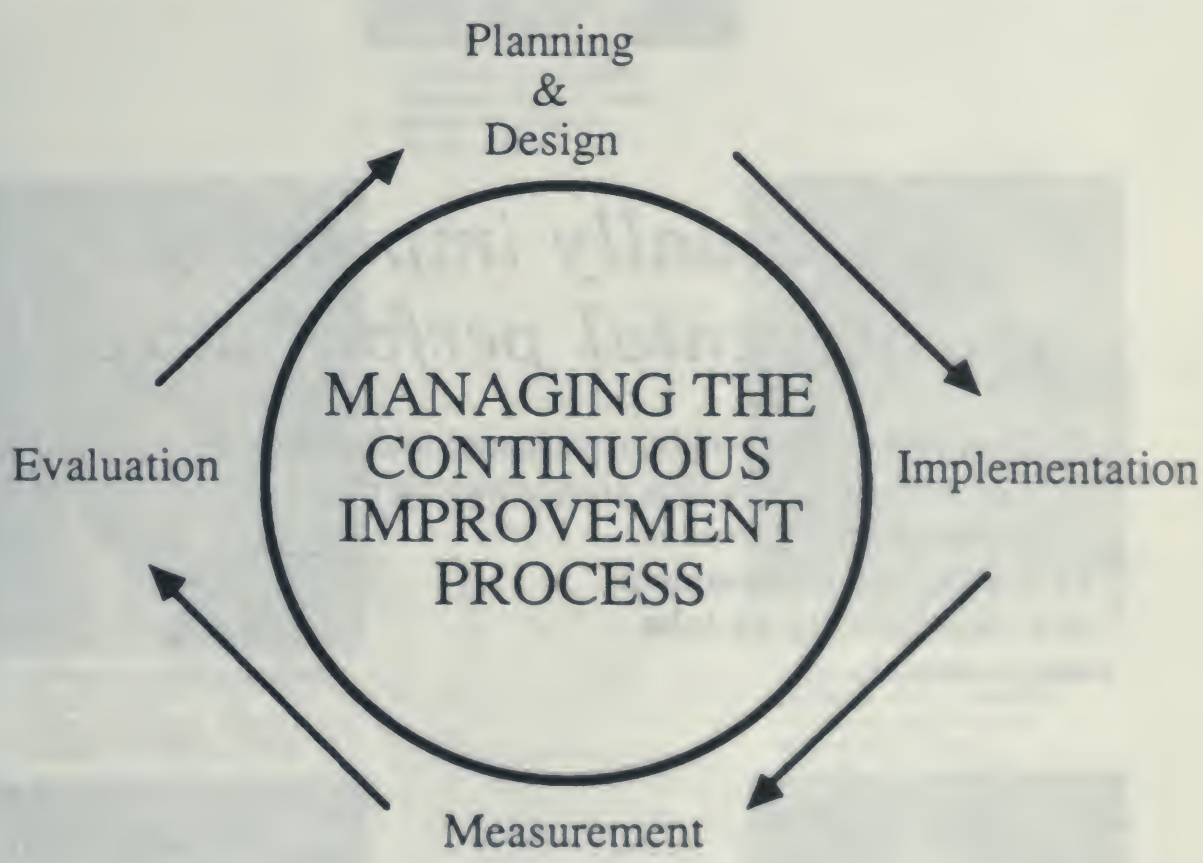


* AS MEASURED BY CURRENT GUIDELINES
** 4th Qtr. 1985

Future Emphasis

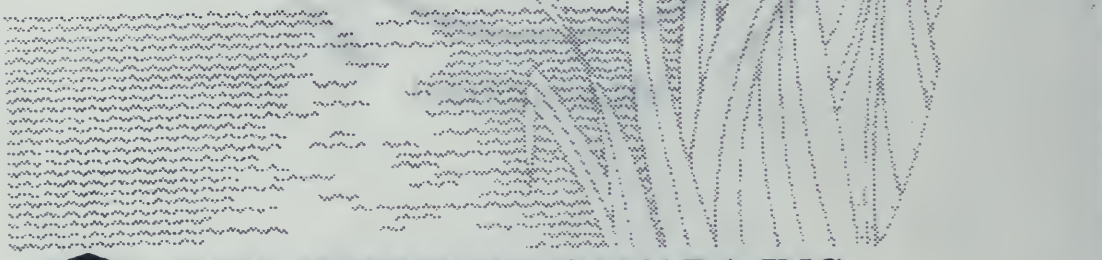
Further sewer separation
Reduction in water use
Expanded use of water recycling
Reduced air emissions

The Continuous Improvement Wheel



Continually improving environmental performance...

... takes resources--people, equipment and money.
Dow's commitment in this area is paying off!
Our track record proves it.
Protecting the environment
is a responsibility we take
very seriously.



DOW CHEMICAL CANADA INC.

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WASTE SITE INVESTIGATION AND REMEDIATION

by

U. Sibul, Supervisor, Waste Site Evaluation Unit, Waste Management Branch, Environment Ontario, Toronto

The Ministry has conducted extensive inventories of closed and active waste disposal sites in the Province since 1979. As a result, the Ministry has records of approximately 3,850 closed and active waste disposal sites in Ontario. The majority of these sites have not posed contamination problems, and only a very small percentage have been shown to contaminate domestic ground water supplies or to have had measurable impacts on surface water quality. However, to rule out any future impacts, the MOE has embarked on a comprehensive, long-term corporate program to review the contamination potential of all known waste disposal sites. As a significant step in this review, a waste site classification system has been developed to allow a phasing of in-house data review and investigations for all sites. Those sites that have the potential to impact human health are being considered first, followed by those sites that may have an impact on the environment only. It is the ultimate intent of the Ministry to have sufficient data on hand for active and closed waste disposal sites to be able to determine if any contamination is present, and to have sufficient monitoring in place to anticipate off-site impacts before they might occur.

The comprehensive program, started in 1985, consists of three main phases:

1) Maintenance of a complete and accurate file on all active and closed sites;

2) Waste site classification regarding potential impact on the environment and human health;

3) Investigation and impact assessment of high priority sites; identification of required remedial actions.

Although the majority of the work associated with Phase I is complete, determination of accurate locations of sites will be ongoing routinely for years to come. Similarly, the Phase 2 classification of old waste disposal sites will be a continuous task as more accurate data become available, and the investigation of sites in Phase 3 will require many years to complete in order to determine the impact potential of a large number of the old sites.

After the discovery of coal tar in 1986 at a number of locations in Ontario (Waterloo, Ottawa, Toronto, Port Stanley, etc.), the MOE conducted an inventory of municipal coal gasification plant waste sites throughout the Province. This inventory was completed in April, 1987 and it identified 41 sites in 36 municipalities. These sites are being handled as a group distinct from the old waste sites described previously because of the hazardous nature of the waste and the urgency to define any possible problems associated with these sites.

Of the 41 sites, 11 were originally identified in 1987 as having a high potential to impact the environment, 6 were in the medium category, and 24 were deemed to present a low potential for impact. These estimates of potential impact were based on limited existing or historic data and consequently the MOE has initiated further investigative work at many of the sites to determine more precisely the existence and location of coal tar waste on the plant sites, and possible impacts at off-site locations. This work will span approximately three years at a cost of about $1.7 million, which also includes inventory of coal tar waste sites associated with industrial processes. The results of this inventory will be known later this year.

Abatement of problems at old waste disposal sites is an ongoing activity as problems are uncovered or identified through the Ministry's investigations. MOE's prime role in these activities is to ensure that the necessary studies and abatement actions are undertaken by the site owners. In case of critical situations, or where the operators of old sites cannot be located, the Ministry may undertake to fund the necessary investigations and remedial actions. The Security Fund, established in 1985, is one source for funding these initiatives and at the present time the fund allows appropriate hydrogeologic investigations to be conducted in areas where serious contamination is anticipated.

MINISTRY OF THE ENVIRONMENT

WASTE SITE INVESTIGATION & REMEDIATION PROGRAM

OBJECTIVE

1. TO DEVELOP AND MAINTAIN AN INVENTORY OF ALL ACTIVE AND CLOSED WASTE SITES

2. TO INVESTIGATE ALL SITES TO ENSURE ADEQUATE DATA ARE AVAILABLE

3. TO ENSURE REMEDIAL ACTIONS ARE UNDERTAKEN

WASTE SITE INVENTORY

- 1979/80 - OLD CLOSED SITES ≈ 1500
  (CLOSED BEFORE 1971)
- 1982/83 - ACTIVE SITES ≈ 1400
- 1986 - ALL CLOSED (1990) & ACTIVE (1339) SITES ≈ 3329
- 1988 - ALL CLOSED (2455) & ACTIVE (1395) SITES ≈ 3850

WASTE SITE INVESTIGATIONS

- ACTIVE SITES - ON-GOING BY FIELD OPERATIONS OF MOE
- CLOSED SITES - BY WASTE MANAGEMENT BRANCH (PRIORITY BASIS)
- (COAL TAR SITES)

THE WASTE SITE CLASSIFICATION SYSTEM

OBJECTIVE

TO ESTABLISH A PRIORITIZATION SCHEME

FOR IN-HOUSE MINISTRY INVESTIGATIONS

AND MONITORING OF WASTE SITES

Waste Disposal Site Classification Scheme

The classification system is based on the following assumptions:

1. Waste at all disposal sites have the potential to produce leachate; leachate can contaminate ground water, streams and lakes. Methane gas can also be produced and can pose an explosion hazard. However, because of natural dilution or the natural attenuation capacity of soils, or due to engineering facilities built into landfills, impacts on humans or the environment may not be detectable at a point of concern.

2. In general, industrial liquid/hazardous waste, because of the highly toxic nature of some of these wastes, are of greater concern than domestic/municipal wastes.

3. For domestic/municipal wastes, the date of closure of the site is important since the rate of leachate and gas production declines with the age of the landfill. For industrial liquid/hazardous waste, because of the high initial concentrations and often low solubilities, leachate and gas production can be maintained at levels of concern for a longer period of time.

4. Waste disposal sites in urban areas are of concern because of the high development density often found around the sites and, if this development doesn't exist, the high potential for future urban encroachment onto the adjacent lands. Waste disposal sites in rural areas are of concern due to the potential for contamination of domestic water supplies.

5. If a domestic/municipal landfill has been closed for at least ten years, and there have been no methane-related concerns, then it is assumed that, unless the site's environment is significantly changed by development, these concerns will not arise in the future.

6. If the material beneath and surrounding a landfill is highly permeable, ground water contamination is of concern; if the material below and surrounding the site is fairly impermeable, surface water contamination is of concern.

All known active or closed waste disposal sites in Ontario have been classified using the same basic criteria in which the waste type and site location determine the classification of a site. "Class A" sites are those that are deemed to have the potential to impact human health because of the proximity to human development; "Class B" sites are those that are deemed to have the potential to impact mainly the environment.

In order for a waste site to be classified, its location must be known. The precise locations of some very old sites are approximate. Once the location of the site is known, it can be determined whether any of the A criteria (accompanying the classification table) apply. From this it can be determined whether the site is a "Class A" or a "Class B" site. If a site is not a "Class A" site, it is automatically a "Class B" site. In only a few cases, the accurate locations of sites are not known and classification is not possible. Further work is on-going to locate these sites.

To further classify the site to 1, 2, 3, etc. (as in Class A1, A2, A3, etc.) the type of waste must be known. At the present time there are many old, closed waste disposal sites for which this is not known; these are therefore classified only as "A" or "B". It will take considerable effort and financial resources to determine the waste type in these sites.

SITE CLASSIFICATION CRITERIA

(TO ACCOMPANY TABLES I & II)

"CLASS A" CRITERIA - HAZARD TO HUMANS

THESE CRITERIA, SINGLY OR IN COMBINATION WITH OTHERS, INDICATE THE HIGHEST HAZARD TO HUMANS; FURTHER INVESTIGATIONS MAY BE WARRANTED TO DEFINE PRECISELY THE HAZARD(S) AND TO DETERMINE ACTIONS NECESSARY IN THE FUTURE.

- EXISTING DWELLING/STRUCTURE (WITH OR WITHOUT WELL) ON SITE
- PRIVATE WELL < 1000 m FROM SITE
- MUNICIPAL WELL < 1000 m FROM SITE
- PERENNIAL STREAM ON SITE OR WITHIN 1000 m FROM SITE AND THERE IS KNOWN DOMESTIC CONSUMPTIVE OR IN-STREAM USE OF STREAM WATER WITHIN 5 km DOWNSTREAM
- LIKELY FUTURE DEVELOPMENT OF LAND IN URBAN AREA OR IN DEVELOPED RURAL AREA
- SIGNIFICANT AQUIFER AT SURFACE OR WITHIN 10 m OF SURFACE AND GROUND WATER MOVEMENT IS DOWNWARD
- PAST PROBLEMS AT SITE

THE FOLLOWING SUPPLEMENT THE FOREGOING CRITERIA AND SHOULD BE NOTED FOR EACH SITE. THEY SHOULD NOT BE USED BY THEMSELVES TO CLASSIFY A SITE AS A "CLASS A" SITE.

- EASY PUBLIC ACCESS TO WASTE OR SITE
- EXISTING MONITORING FOR METHANE GAS, SURFACE OR GROUND WATER
- LANDFILL AREA > 1 ha

"CLASS B" CRITERIA - HAZARD TO ENVIRONMENT

A SITE THAT DOES NOT SATISFY ANY OF THE "CLASS A" SITE CRITERIA IS AUTOMATICALLY A "CLASS B" SITE. THIS CLASSIFICATION INDICATES GENERALLY A LOW POTENTIAL FOR IMPACT ON HUMANS AND FURTHER INVESTIGATIONS REGARDING THESE IMPACTS ARE NOT AS URGENT AT THESE SITES AS AT THE "A" CATEGORY SITES. HOWEVER, THE HAZARD TO THE ENVIRONMENT MAY STILL BE HIGH AND FURTHER INVESTIGATIONS MAY BE NECESSARY TO DEFINE THIS HAZARD.

BGK/bjb
15/12/87

TABLE I: ACTIVE WASTE DISPOSAL SITE CLASSIFICATION

	INDUSTRIAL LIQUID/ HAZARDOUS WASTES		MUNICIPAL/DOMESTIC WASTES	
	URBAN	RURAL	URBAN	RURAL
"CLASS A" CRITERIA (HUMANS)	A1	A2	A3	A4
"CLASS B" CRITERIA (ENVIRONMENT)	B1	B2	B3	B4

TABLE II: CLOSED WASTE DISPOSAL SITE CLASSIFICATION

	INDUSTRIAL LIQUID/ HAZARDOUS WASTES		MUNICIPAL/DOMESTIC WASTES					
	URBAN	RURAL	URBAN			RURAL		
			YEARS CLOSED					
			<10	10-20	>20	<10	10-20	>20
"CLASS A" CRITERIA (HUMANS)	A1	A2	A3	A4	A5	A6	A7	A8
"CLASS B" CRITERIA (ENVIRONMENT)	B1	B2	B3	B4	B5	B6	B7	B8
N P	NO POTENTIAL FOR IMPACT ON HUMANS OR THE ENVIRONMENT							

WASTE SITE REMEDIATION

- SOLUTIONS - SHORT TERM; MAINTENANCE

  LONG TERM; PERMANENT

- ACTIVE SITES
  - SITE CLOSURE
  - ENGINEERING SOLUTIONS

- CLOSED SITES
  - GLOUCHESTER - $1,000,000 +
  - ELMIRA (UNIROYAL) - $≈1,000,000 + REMOVAL
  - UPPER OTTAWA ST. - $2,000,000

COAL TAR SITES

THE PROBLEM

- COAL TAR - SOURCE OF PAH
  - WORKER CONTACT
  - WATER/SOIL/SEDIMENT CONTAMINATION
  - AIR QUALITY

COAL TAR INVENTORY

- MUNICIPAL SITES
  - 41 SITES IN 36 CITIES
- INDUSTRIAL SITES (NOT COMPLETE)
  - ≈ 50 SITES
  - COAL TAR DISTILLATION
  - WOOD DISTILLATION
  - CHARCOAL/COKE OVENS
  - INDUSTRIAL GAS PLANTS
  - CREOSOTING PLANTS
  - ROOFING, TAR PAPER

COAL TAR INVESTIGATIONS

- LOW PRIORITY SITES - 18
- HIGH PRIORITY SITES
  - ON-GOING - 5
  - TO BE STARTED - 14
- COMPLETED - 4

COAL TAR IMPACT ASSESSMENT

- PAH IN - SURFACE WATER
- GROUND WATER
- SOIL/SEDIMENTS
- AIR QUALITY

COAL TAR CLEANUP CRITERIA

- FACTORS: (A) ON-SITE IMPACT
  - PRESENT/FUTURE EXPOSURE
  - WELLS
  - AIR QUALITY
  - SOIL/SEDIMENT

  (B) OFF-SITE IMPACT
  - WELLS (DRINKING WATER)
  - STREAM/LAKE (BIOTA; USE)
  - AIR QUALITY
  - SOIL/SEDIMENT

- REGISTER ON TITLE (NO CLEANUP)

COAL TAR REMEDIAL ACTIONS

- CRITERIA: LIKELY IMPACT ON OR OFF-SITE
- SITES COMPLETED/ON-GOING
  - WATERLOO - $2M
  - RIDEAU R. (OTTAWA) - $15M
  - CHIPPAWA CR. - $1M
  - TORONTO(2)
    - LIBRARY - ≈$1M
    - 26 BERKLEY - $2.5M
  - LEES AVENUE (OTTAWA) - ON-GOING
  - PT. STANLEY - ON-GOING
  - SYDNEY TAR PONDS (N.S.) - $50M
  - VILLE DE SALLE (P.Q.) - $25M

THE ONTARIO WASTE EXCHANGE PROGRAM:
Helping Industries Reduce Waste

by

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and

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1. INTRODUCTION

The Ontario Waste Exchange program has become more active in the past year. The enhanced program has allowed us to help a greater number of people with a greater variety of questions. In my presentation this afternoon, I will outline to you what the Ontario Waste Exchange is; why it was formed; and how you could benefit from using some of our services. I will also give some examples of waste materials directed from disposal and some ideas for waste markets that you may not have known existed.

2. THE ONTARIO WASTE EXCHANGE PROGRAM: The 4 Ws

I will start by outlining the 4 Ws concerning the Ontario Waste Exchange - What; Who; Where; and Why.

2.1 What Is the OWE?

The Ontario Waste Exchange (OWE) is more than the name implies. It is also a technical assistance program whose mandate is to provide free assistance to Ontario's industrial waste generators and help them reduce the amount of waste produced. The co-sponsors of the program - the Ontario Waste Management Corporation (OWMC) and the Ontario Ministry of the Environment (MOE) - are both committed to the goal of waste reduction; and this is evident by their support of the program.

We can provide assistance in a number of different ways, some of which are summarized as follows:

(1) Provision of Waste Exchange contacts, that is, find industrial users for wastes generated in different industry sectors or help find sources of wastes as alternative raw materials.

(2) Provision of Recycling Industry contacts, such as solvent, oil and metal sludge recyclers.

(3) Conduct literature searches on selected waste reduction topics, such as Waste Processing Technologies.

(4) Conduct mini research projects on selected hazardous waste streams. These are funded by Ontario Waste Management Corporation.

(5) Provision of technical assistance in waste reduction.

(6) Conduct plant visits to help point out areas for improved waste management practices.

(7) Presentations to interested groups.

The OWE is also seen as the active component of the Canadian Waste Materials Exchange Program (CWME) in Ontario. The CWME was established in 1978 and, thus, has a decade of experience and contacts (see Figures 1 and 2) As a passive Waste Exchange, the CWME issues a bulletin every 2 months which contains lists of wastes available and wastes wanted by different industry sectors. Subscribers to the bulletin can browse through the booklet to see what interests them. It is, therefore, important to list your waste materials, because no-one can come up with an idea for wste utilization if they do not know that the waste exists. A sample listing form is provided with this paper (Figure 3).

FIGURE 1 - Summary of the Operation of the
Canadian Waste Materials Exchange

January 1, 1978, to March 31, 1988

Number of Participating Companies	3,500
Number of Wastes Listed	2,887
Number of Wastes Enquired About	2,574 (89.2% of listings)
Number of Enquiries	20,842 (7.2 per listing)
Number of Wastes Transferred	539 (18.7% of listings)
Annual Tonnage of Wastes Transferred	320,500 tons
Value of Wastes Transferred	$11.8 million/year

FIGURE 2 - Summary of Waste Quantities Exchanged by Category

To March 31, 1988

	Category	Ongoing Exchanges tons/year	1 Time Exchanges tons	Total
1.	Organic Chemicals	1,191.8	1,037.9	2,229.7
2.	Oils, Fats and Waxes	33,629.5	91,803.0	125,432.5
3.	Acids	1,875.0	10,011.1	11,886.1
4.	Alkalis	13,322.0	63.1	13,385.1
5.	Other Inorganic Chemicals	2,813.2	483.8	3,297.0
6.	Metals & Metal Sludges	15,768.0	477.0	16,245.0
7.	Plastics	1,315.9	472.3	1,788.2
8.	Textiles, Leather & Rubber	5,752.1	23.0	5,775.1
9.	Wood & Paper Products	81,897.0	620.0	82,517.0
10.	Miscellaneous	56,872.0	1,029.0	57,901.0
11.	Lab Chemicals	-	0.1	0.1
		214,436.5	106,020.2	320,456.8

FIGURE 3 - Listing Form)

canadian waste materials exchange la bourse canadienne des déchets

LISTING FORM

(Submit separate form for each listing)

Exchange Use Only

Code # _____

Location _____

1. Company Name: _____ SIC Code: ____ ____ ____ ____
2. Mailing Address: _____
3. Company Contact: _____ 4. Title: _____
5. Signature: _____ 6. Date: _____ 7. Phone ( ) _____
8. Check One Only: ☐ MATERIAL AVAILABLE ☐ MATERIAL WANTED
9. Classifications (review all first, then select one only that best describes your material):

☐ ACIDS	☐ SOLVENTS	☐ PLASTICS AND RUBBER	☐ METALS AND METAL SLUDGES
☐ ALKALIS	☐ OTHER ORGANIC CHEMICALS	☐ TEXTILES AND LEATHER	☐ MISCELLANEOUS
☐ OTHER INORGANIC CHEMICALS	☐ OILS AND WAXES	☐ WOOD AND PAPER	

10. Material to be listed (main usable constituent, generic name): _____
11. The industrial process that generates this waste: _____
12. Main constituent (chemical formula): _____ % _____ in _____
13. Contaminants (highest to lowest, chemical formula): ____ % ____ ____ % ____ ____ % ____ ____ % ____
14. Percentage by (check one): ☐ VOLUME ☐ WET WEIGHT. ☐ DRY WEIGHT
15. Physical State: ☐ SOL'N ☐ SLURRY ☐ SLUDGE ☐ CAKE ☐ AGGREGATE ☐ SOLID ☐ DUST ☐ GAS
16. Miscellaneous appropriate information (pH, toxicity, reactivity, color, particle size, flash point, total solids, purchase date): _____
17. Potential or intended use: _____
18. Packaging: ☐ [illegible] ☐ DRUMS ☐ PALLETS ☐ BALES ☐ OTHER _____
19. Present amount _____ 20. Frequency: ☐ CONTINUOUS ☐ VARIABLE ☐ ONE TIME
21. Quantity thereafter _____ in ☐ lbs. ☐ tons ☐ gal. ☐ C.y. ☐ Kg. ☐ Tonnes ☐ Litres ☐ Cubic Meters ☐ Other _____ per: ☐ Day ☐ Week ☐ Month ☐ Quarter ☐ Year
22. Restrictions on amounts: ☐ none ☐ minimum ☐ maximum _____
23. Available to Interested Parties: ☐ sample ☐ lab analysis ☐ independent analysis
24. For material wanted, acceptible geographic range (i.e. states, provinces, regions, countries) _____
25. For material available, if location of the material differs from the above mailing address, complete the following:

City _____ State or Province _____ Area Code _____

26. If necessary to speed communication, please check if your company name, address and telephone number may be released ☐ YES ☐ NO

2888H/27

ONTARIORESEARCH Sheridan Park Research Community, Mississauga, Ontario, Canada L5K 1B3 (416) 822-4111

The OWE has been provided with editorial space in the CWME bulletin. Since the focus of the OWE is the reduction of hazardous wastes in Ontario, our editorial is generally concerned with these issues. We try to provide the generators with up-to-date information on waste reduction technologies and services. If you think you have a product or service which waste generators would like to hear about, please contact us at the OWE.

2.2 Who Uses the Ontario Waste Exchange?

The OWE provides assistance to anyone working in the waste management field with interests in waste reduction. In the past, we have worked primarily with industrial waste generators. Now, however, with a greater profile for the OWE, we have all kinds of industrial 'clients', including the service industry (equipment and chemical suppliers; waste processors), industrial users of 'waste' as raw materials, consultants who advise on waste management alternatives, waste haulers and government personnel at the various levels.

2.3 Where Is the OWE?

The OWE and the CWME are both operated by Ontario Research Foundation. We are located in the west end of Mississauga, just off the QEW in the Sheridan Park Reseach Community.

The benefits of being at this location are numerous - such as access to the Library services and data bases for literature searches, use of laboratory facilities, as well as top chemists for our mini research projects and the ability to tap into the numerous experts in various fields working at ORF.

2.4 Why Was the OWE Formed?

The OWE was formed in 1984 with sole sponsorship of the OWMC, as part of their commitment to encourage industrial hazardous waste reduction. The original premise of the program was to help effect exchanges of Ontario wastes listed on the CWME that were less attractive to potential users. As well, as an active Waste Exchange, the OWE was also designed to assist the small quantity 1X wastes that needed more immediate attention. In 1987, MOE became co-sponsors which allowed for further expansion of the program and development of those contacts established in previous years.

Both agencies recognized the need to provide free technical assistance to industries that are faced with growing waste management problems. Industries are being faced with rising disposal costs, more regulations governing disposal and public image concerns that make the 4Rs look more like practical alternatives than they have in the past.

3. RATIONALE FOR WASTE REDUCTION

There are basically three main incentives for considering waste reduction or recycling opportunities: economics, legislation and corporate image.

3.1 Economics

Current costs for landfilling solid non-hazardous wastes have been increasing dramatically in Southern Ontario (see Table 1). In many communities, access to landfill space is declining and current landfills are filling up, creating waste management crises

TABLE 1 - Landfill Fee Survey

April, 1988

Location	$/Tonne
Belleville/Napanee	34.00
Essex Windsor	19,86, 19.54, 23.90
Grimsby	50.00
Guelph	28.00
Halton Region	53.50
Hamilton/Wentworth	28.60
London	15.40
Niagara Waste Systems	26.00
Orillia	37.50
Ottawa	27.50
Peel Region	49.50 (July)
Red Lake Area	0
Steetley Industries Ltd.	28.00
Stratford	0
Sudbury Region	0
Timmins	0
Region of Metro Toronto	50.00
Waterloo	30.80

in many municipalities. Of the 8 million or so tonnes of landfillable wastes in Ontario, about half can be attributed to the industrial/commercial sector. To deal with this problem, some municipalities are enacting by-laws to ban the landfilling of certain materials, such as corrugated cardboard and tires. Alternatives to disposal do exist, but these markets need to be competitive with disposal costs. In Metro Toronto and surrounding areas, the tipping fee was recently increased about 200%, and calls to the OWE from industry asking for help in waste reduction soared.

Many municipalities have also realized that local industry could benefit from an industrial waste reduction program serving their own region. There are presently 11 municipalities who have a representative to assist industries in identifying local waste reduction opportunities, and help reduce industrial dependence on landfill sites (see Figure 4). As a result of this flurry of activity at the Regional or Municipal level in implementing both municipal and industrial recycling programs, a group called the Association of Municipal Recycling Co-ordinators has been formed. This Association comprises the designated waste reduction personnel from Regions or Municipalities, the purpose of which is to exchange ideas and information in this rapidly expanding field. The Ontario Waste Exchange is involved by providing assistance and information on markets and technologies. If you would like more information on this Association, please feel free to contact any of the members or the OWE.

Hazardous wastes generated in Ontario have been estimated at about 3.6 million tonnes/year (OWMC Environmental Assessment, Volume 1, February 1988). These wastes require special handling and

FIGURE 4 - List of Contacts for Help on Waste Reduction

(Solid, Non-Hazardous Industrial Wastes)

Essex/Windsor	Geoff Rathbone	(519) 776-6441
Guelph	Dan Hoornweg	(519) 837-5604
Region of Halton	Art Mercer	(416) 827-2151
Region of Hamilton	Beth Goodger	(416) 526-2671
North Simcoe	Liz Downer	
Region of Peel	Glenn Milbury	(416) 791-9400
Peterborough	Mary Simpson	(705) 743-2550
City of Stratford	Brenda Phillips	(519) 271-0250
Region of Metro Toronto	Mary Stewart	(416) 392-6697
Region of Waterloo	Linda Shore	(519) 885-9570 (519) 885-9418
Wellington County	Donald Taylor	(519) 843-4173
Recycling Council of Ontario		(416) 593-1756
Ontario Recycling Information	(Toll Free)	1-800-387-5479

treatment/disposal facilities and are registrable wastes under Regulation 309. The estimate of 3.6 million tonnes, however, cannot be taken as an actual fact, but only as a guideline because, at any time, a so called product or raw material from industrial processes can be designated as a waste due to process failures. Costs for the disposal of hazardous wastes have been increasing very rapidly as well, and can be quite varied, depending on what service or company is employed. In one particular case, an industry obtained five quotes from five different service companies which ranged from $5,000 to $20,000.

Sewer surcharge rates are also increasing in different municipalities across Ontario where these surcharges are employed. In the Region of Peel, for example, surcharge rates have almost doubled in the last seven years (see Figure 5). By 1990, the Region hopes to eliminate this agreement entirely, which will mean that companies having overstrength sewerable wastes will have to implement an appropriate waste reduction and/or treatment program. This poses two serious problems for these industries - capital expenditure and space.

3.2 Legislation

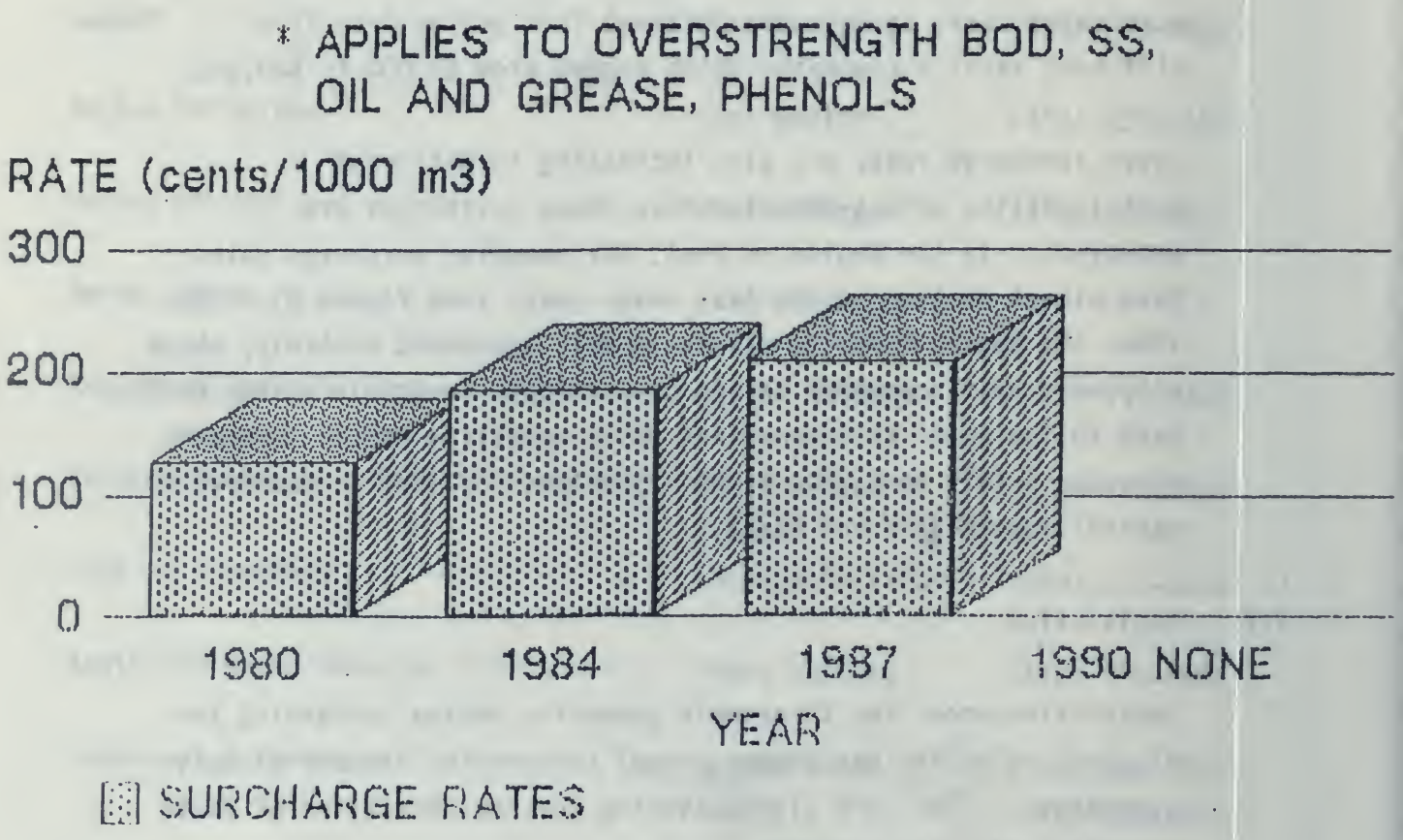
Legislation under the three main governing bodies concerning the disposal of wastes has become a real concern for industrial waste generators. They are also hastening the implementation of waste reduction planning programs.

3.2.1 Regional

In Ontario, the regional governments control the sewer by-law limits. Presently, industry across the province does not have to abide by identical sewer discharge by-laws, which may give some

FIGURE 5 - Sewer Surcharge Rates*

(Region of Peel)



companies a competitive edge. However, when the use of a model sewer by-law becomes province-wide, all industrial sewer discharges will be dealt with equally.

3.2.2 Provincial

The Environmental Protection Act, which is a provincial rule, encompasses Regulation 309 and the Spills Bill. Under Regulation 309, generators of hazardous and liquid industrial wastes must evaluate their wastes and register them with the Ministry of the Environment. This monitoring system will allow the Ministry to develop computerized waste profiles which will serve as a basis for the entire waste monitoring and control system. There is an exemption for registration of wastes if the waste is going directly for recycling purposes, and I understand that the revisions, which include waste chemicals for water treatment purposes, are now in effect.

The Spills Bill has three important goals: (1) prompt reporting of spills of pollutants; (2) clean-up of spills and prompt restoration of the environment; and (3) compensation for victims. There is also the MISA programme - a provincial programme to control direct waste discharges to receiving waters.

3.2.3 Federal

Under the Federal jurisdiction, Tom McMillan promises one of the toughest Environmental Protection Acts in North America, with fines for polluters up to $1 million/day. As well, there is the Transportation of Dangerous Goods Act, which must be adhered to when transporting hazardous waste materials.

These are just some of the rules and regulations that a waste generator should be aware of.

3.2.4 Corporate Image

Lastly, we have Corporate Image. Most companies are concerned with this aspect and want to remain on friendly terms with local governments, the community and the media. No-one wants bad press - it is also bad for business. It can also affect your insurance rates for environmental liability. Environmental liability is concerned with a risk potential, not only with wastes, but also raw materials, and requires a general environmental evaluation.

4. WASTE MANAGEMENT HIERARCHY

For any individual or company involved in waste management, the Waste Management Hierarchy can be seen as an important tool to identify possible alternatives to disposal (see Figure 6). The OWE uses this approach when evaluating potential disposal alternatives of waste materials that are brought to our attention. Figure 7 gives examples of various approaches under each of the categories of Waste Abatement, Minimization, Reuse and Recycling.

5. MATERIALS EXCHANGED AT OWE

The OWE has been able to assist numerous companies with their waste problems. Examples of wastes that have been diverted from disposal are shown in Figure 8, as well as their designated receivers. The material's are grouped according to the eleven different categories as used by the CWME bulletin.

FIGURE 6 - Waste Management Hierarchy

Waste Abatement	Don't Make It
Waste Minimization	If you have to make it, minimize its volume and toxicity
Waste Reuse	See if someone else can use it
Waste Recycle	If it can't be used as is, reclaim as much as possible that is useful
Waste Treatment	Treat what can't be reclaimed to render it safe
Waste Disposal	Dispose of residues to air, water or land

FIGURE 7 - Waste Reduction Approaches

	Examples
WASTE ABATEMENT Substitution of a new low-waste primary industrial process for an old process to eliminate or drastically reduce the quantity of waste produced	- Replacement of sulphuric acid in steel pickling with hydrochloric acid - Replacement of liquid paints by powder coatings - Replacement of solvent based adhesives with water based adhesives
WASTE MINIMIZATION The reduction of the quantity of waste through good house-keeping practices or by the application of concentration technologies. Also the reduction in the degree of hazard of waste through simple in-plant treatment	- Separation of waste streams to permit recovery - Application of countercurrent rinsing to minimize volume discharge - Neutralization of wastes and precipitation of smaller volume sludges - Fixing leaky taps and nozzles
WASTE REUSE The direct reuse of a waste stream, as is, or with a very minor modification	- Reuse of surplus or salvage chemicals - Use of blast furnace slag as aggregate - Use of solvents from electronics industry in paints manufacture - Use of refinery spent caustic in pulping wood - Use of oil sludges in asphalt manufacturing - Use of electronic circuit manufacturing plating baths in regular plating shops
WASTE RECYCLE The reclamation of value from waste streams through the application of reprocessing technologies such as distillation, etc.	- Oil rerefining - Solvent distillation - Recovery of iron salts from pickle liquor - Recovery of heavy metals from sludges - Recovery and reuse of spent foundry sands - Recovery of scrap metal - Landfarming of organic wastes - Regeneration and reuse of activated carbon - Recycling of grease and fats to renderers

FIGURE 8 - Waste Exchanges

MATERIALS	RECEIVERS
(1) Acids	
Nitric Acid	Metal Reclaimer
Sulphuric Acids	Metal Reclaimer
(2) Alkalis	
Calcium Hydroxide	Broker to New Business
(Potassium Hydroxide	Chemical Company
(3) Other Inorganic Chemicals	
Alumina	Abrasives Manufacturer
Asbestos (unused)	Manufacturer for Reblend
Foundry Sands	Asphalt Manufacturer
(4) Solvents	
Degreasing Solvents	Replaced with Biodegradable Solvent Substitute
Ink Wastes	Recycling & Recovery
(5) Other Organic Chemicals	
Isocyanates & Polyols	Reuse in Polyurethane Foam Product
Paints	Salvation Army
Latex Materials	Manufacturer for Reblend
(6) Oils, Fats & Waxes	
Gasoline (Experimental)	Charity Organization
Oils (PCB Free)	Oil Recycler
(7) Plastics and Rubber	
Polystyrene (Water Damaged Pack)	Plastic Recycler
Plastic Drums	Municipal Composting Programs

FIGURE 8 - Waste Exchanges (Contd.)

MATERIALS	RECEIVERS
(8) Textiles and Leather	
Cotton Textile Waste	Buffing Wheels
(9) Wood and Paper Products	
Christmas Trees (Commercial Operation)	Chipped for Parks and Recreation
Wood Ends	Pressboard Manufacturing
Old Corrugated Cardboard	Cardboard Recycler
(10) Metals & Metal Containing Sludges	
Copper & Nickel Nitrate Solutions	Metal Recovery
Mercury	University Lab for Experiments
Vanadium Catalysts	Vanadium Reclamation
(11) Miscellaneous	
Cement Plant	Dismantled for Scrap
Yeast, Popcorn, Dairy Products	Animal Feed

6. COST SAVINGS BY WASTE REDUCTION

Many companies are also seeing a net benefit by recycling their waste or by-product materials. Figure 9 gives examples of cost benefits to companies with particular solid non-hazardous industrial wastes and Figure 10 shows examples of cost benefits for recycling hazardous wastes.

7. BREAKING THE BARRIERS

7.1 Market Development for Waste Recycling

The business of waste reduction and minimization is growing very rapidly, providing new alternatives to disposal of waste materials. A new industry sector is developing with which the OWE is ready to help. In particular, the OWE is assisting the following new market sectors in waste reduction opportunities:

(1) Expansion of the traditional recycling industries so that they receive a greater range of materials, i.e. in solvent recovery operations.

(2) Industries that do not operate waste management facilities are starting to receive industrial 'wastes' as substitutes for raw materials, i.e. a vanadium mine receiving spent catalysts for vanadium reclamation.

(3) Service industries are expanding to include reuse and recovery options for their clients, i.e. the pick up of waste solvents from small quantity generators.

FIGURE 9 - Cost Benefits of Recycling Solid Non-Hazardous Industrial Wastes

Material	Benefit
Old Corrugated Cardboard	New service industry recycles old corrugated cardboard and saved in all $60,000
Scrap Plastics	i.e. paid approximate 22¢/kg
Wooden Pallets	- Repair cost: $4.00/piece - Waste disposal cost reduced by $4,000/year - Savings in pallet replacements $9,600/year

FIGURE 10 - Disposal vs Recycling for Secure Landfill/Incineration
Not Including Transportation and Travel Costs

	Disposal Costs $/Drum	Off-site Recycling $/Drum
Spent Cyanide Wastes from Plating Baths	550-800	350
Chrome Sludge	140	70
Waste Oils	25	0
Spent Nitric Acid	150	100
Waste Solvent (i.e. 1.1.1. Trichloroethane)	300-700	50

(4) New products are being developed that use processes requiring fewer hazardous materials, i.e. the biodegradable solvent substitutes for degreasing.

(5) New industries developed solely for waste recovery and reuse, i.e. landfarming/biodegradation of organic wastes and metal reclamation from sludges.

7.2 OWE Research Projects

Ontario Research Foundation is involved in a number of research programs directed toward increasing the technical efficacy of waste reduction and reuse. These are being conducted through the Ontario Waste Exchange, by in-house funding, and through direct contracts with industry.

The type of research that is required at present to encourage waste reduction and reuse is not the fundamental development of brand new concepts. It is much more research into the application of existing technologies to new problems and the refining of those technologies to make them more economic.

A few examples of the kinds of small research projects which ORF has undertaken are given below. These projects have been funded by OWMC as part of their support of the Ontario Waste Exchange program.

- Waste sulphuric acid from the drying of hydrocarbons was difficult to recycle because of the black coloration of the acid. A chemist at ORF found that, by heating with 1% HNO_3, the black colour disappeared, resulting in an acid with a greater potential for recycling.

- A malic acid mixture being produced by a food products company was examined for potential reuse. The separation of malic acid from the waste stream was studied and concentration methods were recommended. The study also included other potential uses for a mixed malic acid product, one of which was its application to chrome containing leather shavings. Leather scraps and shavings cannot be landfilled because of the high potential for chrome leaching from the material. Treating the material with the spent malic acid could be controlled to just leach out the chrome or to dissolve both chrome and leather. The chromium can be recovered by precipitation and filtration and the dissolved leather could potentially be converted to animal glue or gelatin.

- Three hazardous solid wastes were examined for their potential use as aggregates in cement:

- Grey iron foundry dust
- Steel slag
- Foundry sand

  The conclusion from this work was that foundry sand appeared to have the greatest potential as an aggregate in Portland Cement.

- A final example was a project examining the potential for wastes containing high percentages of carbon to substitute for activated carbon. None were as good as activated carbon in absorbing materials from wastewater streams. One waste, particularly, a carbon concentrate from bituminous coal flyash, showed very good capacity when pretreated by acid leaching.

8. SUMMARY OF OWE ACTIVITIES 1987-1988

The activities of the OWE as they relate to successful waste diversions are summarized in Table 2. These values include both one time and ongoing waste reduction efforts.

As previously mentioned in this paper, the OWE was originally designed to assist in the transfer of the less desirable wastes and those small quantity one time generators that had to dispose of their wastes "yesterday".

The waste quantities that had been effectively directed from disposal in the three years before the program reached its greater operating capacity was 119 tonnes, representing 11 different materials. Because the types of waste materials are those that do not have immediately recognizable markets, the time it takes to effect an exchange is much greater. However, with our rapidly expanding data base and our growing experience with various types of wastes, we will gradually be able to handle your queries more effectively.

Exchanges of wastes, however, in all of the waste categories will usually take a fair amount of time. Liability questions, product quality and quantity and distance to transport are all questions a potential user of the waste materials must be comfortable with. Waste generators can assist by making as much information as they have about their wates available to interested parties.

Some of the current projects that the OWE is actually working on to help both generators and potential receivers of waste materials are as follows:

TABLE 2 - Summary of OWE Activities

Activity Year	# of Materials Diverted from Disposal	Quantity Diverted (tonnes)	# of Contacts	Potential Quantities Diverted (tonnes, current projects
1984-1985	2	20.7		
1985-1986	7	95.1		
1986-1987	2	3.1		
1987-1988	63	450.0	1,400	20,000 +
Totals	74	568.9	1,400	20,000 +

Acids (various types)
Alumina
Anodizing Wastes
Food Wastes
Metal Sludges
Polyurethane Foams
Paper Wastes
Reclaimed Solvents
Titanium Bearing Wastes
Vanadium Bearing Wastes
Zirconium Wastes

If you are interested, as a generator or receiver, in any of these in particular, please contact the OWE.

One of the main difficulties in operating this type of a program is monitoring the success rate. If we have been able to help you - we would like to hear about it - and, if we have not been able to help, we would still like to hear about it because we could come across a better answer to your problem.

ENVIRONMENTAL & PROJECT DEVELOPMENT ASPECTS OF FIRING REFUSE DERIVED FUEL IN A CEMENT KILN

by
Charles Coles, St. Lawrence Cement, Inc., Mississauga, Ontario

1. Introduction

Disposal of non-hazardous Municipal Solid Waste has become a critical problem, particularly in large urban areas such as the Golden Horseshoe. It is increasingly obvious that the situation can only be brought under control by utilizing all disposal alternatives to some degree: recycling, landfill and energy from waste.

St. Lawrence Cement is presently developing a project to replace up to 20% of the coal used to fire our large cement kilns with Refuse Derived Fuel. This would then significantly reduce the quantity of waste disposed of at the local landfill sites, while at the same time reducing the coal required in the process to produce cement. The burning of this fuel in a cement kiln offers some particularly unique environmental advantages. Because this processing of waste produces a useful product, while at the same time reducing the consumption of a natural resource this process is regarded as a recycling project.

It was St. Lawrence Cement's goal from the outset of this project that the local community be completely involved in the development of the project.

To accomplish this, a unique organization structure for the evaluation of the project was established.

Since the project was originally conceived and the initial discussions were held with the local municipalities, four years have passed. We are now at the stage where we will be submitting our Draft Environmental Assessment Document to the Environmental Assessment Branch.

2. The Cement Manufacturing Process

When we utilize the term Refuse Derived Fuel, essentially we are referring to a fuel that is produced when post recycled solid, non-hazardous waste is processed. The Resource Recovery plant separates the burnable portion of the waste as Refuse Derived Fuel, as well as separating metal, compost and the rejected material to be returned to the landfill site.

St. Lawrence Cement began to study the possibilities of utilizing Refuse Derived Fuel in our kilns due to two main reasons - energy conservation and waste reduction. Energy conservation because cement manufacturing is a large fuel consumer. The cement manufacturing process ranks behind only steel and chemicals as the largest fuel consuming process. In fact, fuel costs comprise approximately 1/3 of our

total manufacturing costs. Waste reduction because both the Regions of Peel and Halton had identified Energy from Waste in some form as a necessary component to solving the regions' solid waste management problems. St. Lawrence Cement felt that we had the best process to co-operate with the regions in this endeavour and it is for that reason that our plant has been identified in the Peel Waste Master plan.

The cement manufacturing process is a relatively simple process. The main component is limestone and that is quarried at Colborne, approximately 150 km east of the plant. The limestone is shipped in a primary crushed state (minus 200 mm) by ship to the manufacturing plant in Mississauga. Approximately 2.5 to 3 million tonnes of limestone are shipped annually since it requires 1.5 tonnes of limestone to produce 1 tonne of cement. The limestone is stockpiled at the back of the plant because the ship does not operate during the winter months. This limestone is then reclaimed as it is required in the process. The limestone, together with small portions of other raw materials such as shale, iron pyrite or sand, (these additives produce the correct chemical composition of the ground raw material mix) are fed to a large ball

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mills where it is ground into a fine powder. At the Mississauga plant, there are two processes, the wet and dry process. In the dry process, the ground limestone remains in the dry state and is called raw meal. In the wet process, approximately 1/3 water is added to the ground raw materials, with that, it becomes a thick permeable material known as slurry. The slurry or raw meal are then stored in special storage silos.

From the storage silos, the raw meal or slurry is fed to either the wet or dry process kilns. The kilns are a continuous process where the material is heated to a final temperature of 1400 deg. C. Essentially, at this temperature, the raw materials are in a semi-molten state and it is here that the chemical reactions occur that give the final cement powder its hydraulic characteristics. The product discharged from the kiln is called clinker and it is a semi-finished product at this state. It is in the kilns where the high fuel consumption occurs and where the Refuse Derived Fuel would be used as a partial fuel replacement. This process offers a number of particularly unique advantages for the burning of Refuse Derived Fuel.

1. The flame temperatures are exceedingly high 1700 deg - 2100 de C resulting in the destruction of harmful compounds. There is also the safeguard that these temperatures must be maintained to produced a quality product.
2. The retention time at these high temperatures is extremely long 7 - 12 seconds compared to an incinerator where the retention time is one second maximum.
3. There is no ash to dispose of because it becomes part of the product.
4. The limestone feed to the kiln provides a scrubbing action for the exhaust gases.

From the kiln, the semi finished product, clinker, is conveyed to storage. From the storage area, the clinker is fed to large grinding mills where it is ground into a fine powder, together with approximately 5% gypsum. The resulting product is Portland Cement. Cement is not to be confused with concrete. Cement is a gray powder that is shipped in either bulk or bag. Concrete is the ultimate final product that is produced when cement is combined with sand, stone and water. It is concrete that is used for constructing roads, buildings, etc.

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3.0 Environmental Aspects

The first step in the study was to make a detailed environmental analysis of the process in order to fully evaluate the environmental impact of substituting Refuse Derived Fuel for coal in the cement manufacturing process. This study was conducted by the Ontario Research Foundation. The initial study was conducted for only kiln 3, the large precalciner kiln. A new report has recently been issued covering all 3 kilns at the Mississauga plant.

The study was conducted in the following manner. Based on information provided by St. Lawrence Cement and obtained from a number of other sources, a material balance was prepared for current kiln operations when coal alone is used as the fuel. Then, similar material balances were prepared to reflect the use of RDF in the three different combinations to partially replace coal. A comparison of the material balances showed that neither the flowrates nor the composition of the major gaseous components in the stack gases will change significantly with RDF usage. As a result, the dispersion characteristics of the Kiln Stack gases will not change significantly with the RDF program, provided that there are no other operating changes.

Projected emission rates of Kiln Stack components,

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other than the major gaseous components, when the RDF program is implemented were obtained by a review of information from the following sources:

- actual emission tests carried out at Kiln #1, Kiln #3 and the Coal mill during normal plant operations when coal alone is used as the fuel.
- analyses of raw meal, waste iron oxide, coal and RDF samples typical of the material presently used in the kilns or expected to be used in the kilns
- literature survey of coal, RDF and municipal solid waste combustion

These following emission component groups were included in the environmental assessment:

- particulate material
- acid gases
- metals
- inorganic elements
- polychlorinated organics
- polycyclic aromatic hydrocarbons.

From an environmental perspective, these are the components which are generally considered to be the most important in flue gases discharged from coal and RDF combustion.

Emission rates from the Kiln Stack for the components associated with the current use of

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coal as a fuel, the planned use of coal as a fuel, and three RDF options were combined with the results of various dispersion models to derive predicted ground level component concentrations. Half-hour "point-of-impingement" concentrations were derived using the prescribed calculations in Regulation 308 of the Ontario Environmental Protection Act. Models proposed by the MOE to replace the existing models in Regulation 308 were used to calculate maximum 1-hour concentrations. The set of models proposed by the MOE include a lake-breeze model, which predicts maximum 1-hour concentrations of components from a stack situated near a body of water. This model was used to predict the effect of such a lake breeze on the St. Lawrence Kiln Stack. Long-term concentrations (annual) were predicted with the use of the United States Environmental Protection Agency (USEPA) Industrial Source Complex Long Term (ISCLT) model, in an attempt to determine long-term effects of the emissions from the facility.

Predicted concentrations were compared with levels defined in Regulation 308, Regulation 296, the MOE tentative standards, guidelines and provisional guidelines, and the MOE proposed air quality standards.

Under existing air quality standards and guidelines, the predicted concentrations attributable to the St. Lawrence Kiln Stack are not expected to exceed 9% of any allowable level, with most contaminants expected to be less than 0.1% of allowable levels. Concentrations are not expected to exceed 16% of the MOE's proposed standards, with most contaminants less than 0.1% of these standards.

The detailed information is summarized in table 12 from the Ontario Research Foundation report which is attached to this paper.

4. Development of the Project

The beginning of this project dates back to 1984, when St. Lawrence Cement recognized that the time had arrived to consider replacing a portion of the kiln fuel with Refuse Derived Fuel. The cement kiln has been recognized for a number of years as a superior process for the destruction of waste. Since the Regions of Peel and Halton were both facing serious refuse disposal problems and the fuel requirements of the cement kiln are high, it was realized that a Refuse Derived Fuel study should proceed.

A preliminary feasibility study was made and this showed that such a project was indeed a viable consideration. The environmental study as we have just

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seen showed, as expected, that the burning of Refuse Derived Fuel in the cement kiln was an environmentally sound concept.

Support was indicated from both the Regions of Peel and Halton and the City of Mississauga and the project study started in earnest. Proctor & Redfern were hired as consulting engineers and Turkstra Mazza Munroe as legal counsel.

An organizational structure was established keeping several key considerations in mind.

1. It is necessary to communicate effectively with all groups and jurisdictions openly and completely at all stages, as the project develops.
2. The cement manufacturing process is environmentally superior to all other alternatives and, as such, we should not hesitate to have all aspects of the project evaluated.
3. Communication and involvement in the development of the process is crucial to the acceptance of the project.
4. There will only be one opportunity to proceed with any waste project in the next few years. If the political process is not well done and fails, it will not be possible to institute another waste project in the near future.

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The Organizational Structure that was established to address the political aspects of the project is illustrated in Figure 5. As can be seen, this organizational structure is ultimately responsible to St. Lawrence Cement. Each group has a key function in the development of this project.

Project Steering Committee

This committee is comprised of representatives from the following organizations: St. Lawrence Cement; Holderbank Consulting Ltd.; Ontario Research Foundation; Proctor & Redfern, Consulting Engineers; Turkstra-Mazza, Lawyers; Media Plus, Communications.

The committee develops and reviews the technical information required for the project, as well as the strategy required for the progress of the project. The technical reports that have been prepared and reviewed by the members of this committee to date are the following:

-"St. Lawrence Cement, Inc. Fuel Cost Reduction Study- Study Document No. 1"

-"Technical Feasibility Study of the Use of Refuse Fuel (RDF) by St. Lawrence Cement, Inc."

-"Preliminary Assessment of Air Emissions for the St. Lawrence Cement RDF Study"

-"St. Lawrence Cement Preliminary Planning Report"

-St. Lawrence Cement RDF Plant Transportation Aspects"

-"Haul Route Impact Analysis"

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- an independent, but knowledgeable chairperson
- 3 St. Lawrence Cement representatives
- 3 representatives from the Community Liaison Committee
- 4 municipal staff representatives from the local and regional municipalities.

This group reviews the details of all documentation that is prepared, recommends other studies to be undertaken and reviews all reports that are prepared. They have decision making power and their recommendations with respect to the project will be received and reviewed by the company.

5. Conclusions

The utilization of Refuse Derived Fuel to replace up to 20% of the coal utilized in the manufacture of cement at St. Lawrence Cement's Mississauga plant is viable. This RDF fuel can be produced from the processing of post source separated Non-Hazardous Municipal Solid Waste. This project will significantly reduce the quantity of waste to be landfilled in the Regions of Peel and Halton while at the same time reducing the coal requirements of the St. Lawrence Cement plant. The study results indicate that the cement kiln is an environmentally superior process in which to utilize waste fuels. The involvement of the local community is critical to the successful development of a project such as this.

-"Report on Recycling Programs"

- A number of reports relating to the Assessment of various alternatives for the Fuel Cost Reduction Study following the Environmental Assessment procedure leading to the final report "Description of the Undertaking".

One of the most important strategy aspects of the project that the Steering Committee developed was this organization structure. The committee has developed key areas of the project communication plan which has involved, to date, newspaper press releases, newspaper advertisements, a television news report, radio interviews and a newsletter for the local residents.

Community Liaison Committee

The Community Liaison Committee is comprised of representatives of local citizens groups, the local environmental groups and local citizens who have an interest in the project. The prime function of the group is communications. The committee receives all information with respect to the progress of the project and provides feedback from the community at large. This committee has nominated 3 representatives to sit on the Project Study Group. Approximately 15 to 20 people are present at the meetings.

Project Study Group

This group is charged with the responsibility of producing recommendations with respect to the development of the overall project. It is comprised of:

ABLE 12: Maximum Ambient Concentrations due to All Operations Compared with Proposed Ambient Air Quality Standards

ontaminant	Proposed Air Quality Standard (ug/m3)	Averaging Time	CURRENT OPERATIONS COAL ONLY Max Conc (ug/m3)	CURRENT OPERATIONS COAL ONLY Percent of Prop Stds	PLANNED OPERATIONS COAL ONLY Max Conc (ug/m3)	PLANNED OPERATIONS COAL ONLY Percent of Prop Stds	PLANNED OPERATIONS 20% RDF KILN 3 Max Conc (ug/m3)	PLANNED OPERATIONS 20% RDF KILN 3 Percent of Prop Stds
uspended Particulate	120	24-h	18.147	6.202	15.872	5.424	15.872	5.424
	60	1-y	18.147	2.372	15.872	2.074	15.872	2.074
ulphur Dioxide	690	1-h	78.839	11.426	60.681	8.794	60.566	8.778
	275	24-h	78.839	11.757	60.681	9.049	60.566	9.032
	55	1-y	78.839	11.241	60.681	8.652	60.566	8.636
arbon Monoxide	36200	1-h	25.527	0.071	19.769	0.055	24.467	0.068
	15700	8-h	25.527	0.091	19.769	0.070	24.467	0.087
itrogen Dioxide	200	24-h	80.496	16.506	65.551	13.441	61.196	12.548
ydrogen Chloride	40	24-h	2.334	2.393	1.834	1.880	1.834	1.880
ntimony	3	24-h	0.0000008	0.00001	0.000005	0.00008	0.000005	0.00006
rsenic	0	24-h	0.0001	0.020	0.0002	0.023	0.0002	0.023
arium	10	24-h	0.003	0.012	0.003	0.011	0.003	0.011
eryllium	0.01	24-h	0.00002	0.062	0.00002	0.063	0.00001	0.061
oron	35	24-h	0.036	0.042	0.030	0.035	0.030	0.036
admium	2	24-h	0.002	0.043	0.002	0.034	0.002	0.035
alcium	10 (1)	24-h	3.911	16.040	3.939	16.153	3.941	16.160
hromium	2	24-h	0.009	0.257	0.008	0.219	0.009	0.251
opper	50	24-h	0.001	0.001	0.001	0.001	0.001	0.001
ron	4	24-h	0.231	2.370	0.214	2.197	0.213	2.186
ead	5	24-h	0.091	0.747	0.071	0.583	0.080	0.653
agnesium	100 (2)	24-h	0.168	0.069	0.165	0.068	0.166	0.068
anganese	10	24-h	0.009	0.036	0.008	0.033	0.008	0.033
ercury	2	24-h	0.003	0.068	0.003	0.055	0.004	0.073
ickel	2	24-h	0.009	0.185	0.008	0.155	0.008	0.162
elenium	10	24-h	0.0000008	0.000003	0.0002	0.001	0.0002	0.001
ilver	1	24-h	0.0002	0.010	0.0002	0.008	0.0002	0.008
ellurium	10	24-h	0.0000008	0.000003	0.00002	0.00006	0.00002	0.00006
in	10	24-h	0.004	0.016	0.003	0.014	0.004	0.016
itanium	35	24-h	0.028	0.033	0.026	0.030	0.027	0.032
anadium	2	24-h	0.001	0.014	0.001	0.013	0.001	0.013
inc	100	24-h	0.046	0.019	0.036	0.015	0.038	0.015
CDD	0.00003	1-y	0.00000005	0.015	0.00000005	0.013	0.00000001	0.028
CDD + PCDF mixtures	0.00003	1-y	0.00000003	0.017	0.00000003	0.014	0.00000002	0.030
hlorobenzenes	35 (3)	24-h	0.000005	0.000006	0.000005	0.000005	0.00003	0.00004
hlorophenols	20 (4)	24-h	0.000005	0.00001	0.000004	0.00001	0.00003	0.00007
CB	0.15	24-h	0.00001	0.004	0.00001	0.003	0.000010	0.003
AH	0.0011 (5)	24-h	0.0003	10.336	0.0002	9.068	0.0002	7.859

Notes:
(1) as calcium oxide
(2) as magnesium oxide
(3) as trichlorobenzene
(4) as pentachlorophenol
(5) as benzo(a)pyrene

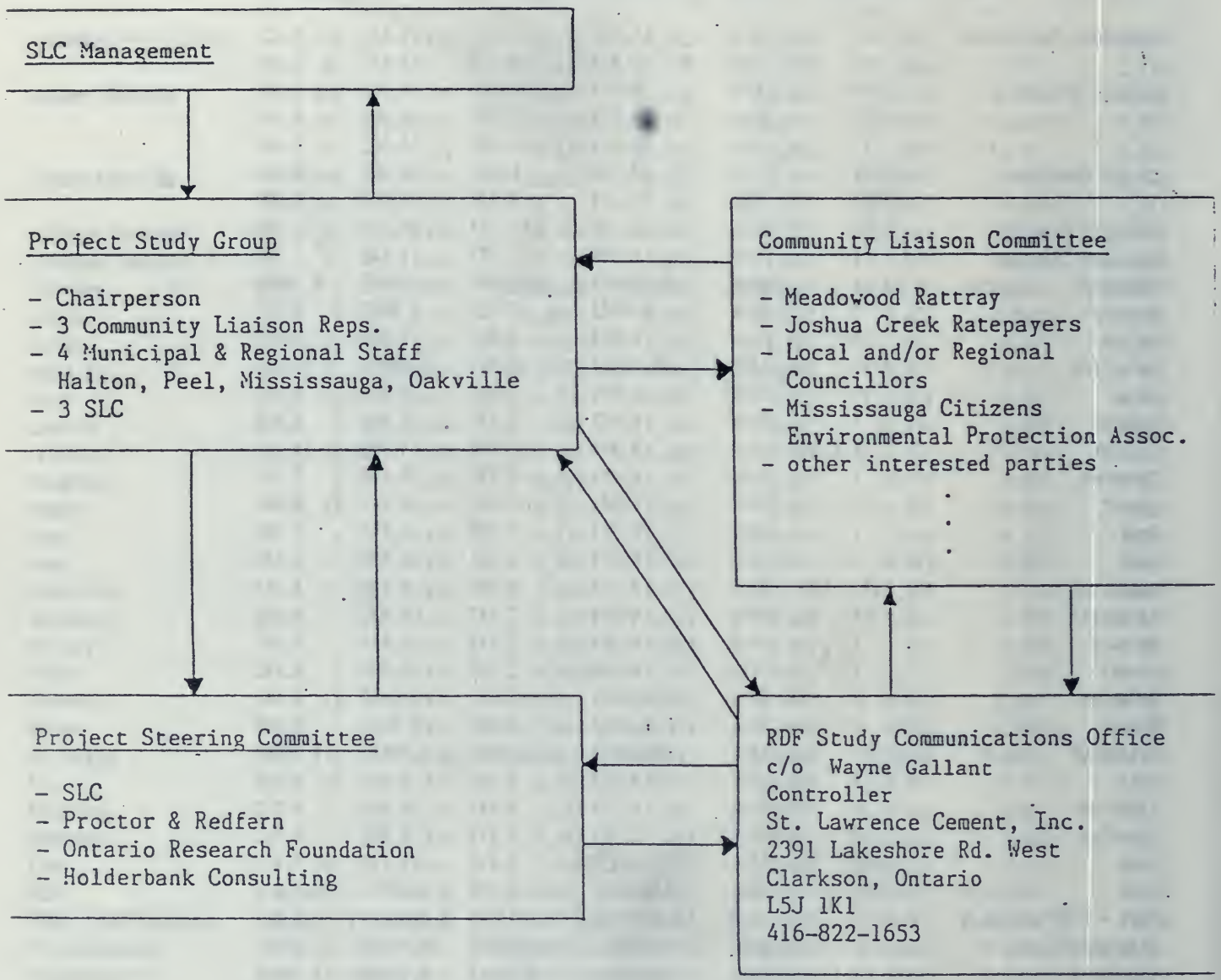
TABLE 12 CONT: Maximum Ambient Concentrations due to All Operations Compared with Proposed Ambient Air Quality Standards

Contaminant	Proposed Air Quality Standard (ug/m3)	Averaging Time	PLANNED OPERATIONS 20% RDF KILNS 1 & 2 10% RDF KILN 3 Max Conc (ug/m3)	Percent of Prop Stds	PLANNED OPERATIONS 20% RDF KILNS 1 & 2 20% RDF KILN 3 Max Conc (ug/m3)	Percent of Prop Stds
Suspended Particulate	120	24-h	15.872	5.424	15.872	5.424
	60	1-y	15.872	2.074	15.872	2.074
Sulphur Dioxide	690	1-h	59.019	8.553	58.962	8.545
	275	24-h	59.019	8.801	58.962	8.793
	55	1-y	59.019	8.415	58.962	8.407
Carbon Monoxide	36200	1-h	22.118	0.061	24.467	0.068
	15700	8-h	22.118	0.079	24.467	0.087
Nitrogen Dioxide	200	24-h	54.492	11.174	52.372	10.739
Hydrogen Chloride	40	24-h	1.948	1.997	1.948	1.997
Antimony	3	24-h	0.000005	0.00008	0.000005	0.00008
Arsenic	0	24-h	0.0002	0.023	0.0002	0.023
Barium	10	24-h	0.003	0.011	0.003	0.011
Beryllium	0.01	24-h	0.00001	0.061	0.00001	0.059
Boron	35	24-h	0.031	0.036	0.031	0.037
Cadmium	2	24-h	0.002	0.035	0.002	0.036
Calcium	10 (1)	24-h	3.940	16.158	3.941	16.163
Chromium	2	24-h	0.009	0.235	0.009	0.251
Copper	50	24-h	0.001	0.001	0.001	0.001
Iron	4	24-h	0.213	2.185	0.213	2.180
Lead	5	24-h	0.081	0.663	0.085	0.696
Magnesium	100 (2)	24-h	0.165	0.068	0.166	0.068
Manganese	10	24-h	0.008	0.033	0.008	0.033
Mercury	2	24-h	0.004	0.079	0.004	0.091
Nickel	2	24-h	0.008	0.159	0.008	0.162
Selenium	10	24-h	0.0002	0.001	0.0002	0.001
Silver	1	24-h	0.0002	0.008	0.0002	0.008
Tellurium	10	24-h	0.00002	0.00006	0.00002	0.00006
Tin	10	24-h	0.004	0.015	0.004	0.016
Titanium	35	24-h	0.027	0.031	0.028	0.032
Vanadium	2	24-h	0.001	0.013	0.001	0.013
Zinc	100	24-h	0.037	0.015	0.038	0.015
PCDD	0.00003	1-y	0.0000001	0.028	0.0000001	0.026
PCDD + PCDF mixtures	0.00003	1-y	0.0000007	0.030	0.0000007	0.027
Chlorobenzenes	35 (3)	24-h	0.00003	0.00004	0.00005	0.00006
Chlorophenols	20 (4)	24-h	0.00003	0.00007	0.00005	0.00010
PCB	0.15	24-h	0.00001	0.003	0.000009	0.003
PAH	0.0011 (5)	24-h	0.0002	7.868	0.0002	7.263

Notes:
(1) as calcium oxide
(2) as magnesium oxide
(3) as trichlorobenzene
(4) as pentachlorophenol
(5) as benzo(a)pyrene

ST. LAWRENCE CEMENT, INC. REFUSE DERIVED FUEL STUDY

ORGANIZATION STRUCTURE



APPLYING MATERIAL BALANCE TECHNOLOGY

TO INDUSTRIAL WASTE MANAGEMENT

by

W. R. Lightowlers, Ontario Waste Management Corporation, Toronto, Ontario

In the area of Waste Management and indeed in all aspects of Environmental Management, we find ourselves in rapidly changing and often bewildering situations. We have evolved in a few short years to a point where the environment, which used to be a non issue, is now a challenge which absorbs the highest levels of managerial and technological talent. In this time of rapid change, there are some important trends that cannot be ignored by the modern Environmental Manager.

Standards

There has been a constant trend to higher and tighter environmental standards in all areas. In enlightened circles the issue is no longer to meet standards but to anticipate trends and prepare for future changes in standards. The management of change is a serious issue for anyone working in this field.

Management

The importance of environmental issues such as cost, compliance and liability have raised the level of environmental concerns to the top management level. Growth, new development and even the viability of existing activities can be challenged by the pressures of sound environmental management. These issues are now finding their way onto the agendas of Vice-Presidents, Presidents and Boards of Directors.

Approach

There is a rapidly growing change from the management of symptoms to a closer investigation of the root causes and opportunities related to environmental management. Production processes which were once considered to be sacred and confidential aspects of industrial activity are now considered as fair game for the evaluation of environmental management practice. Managers are now beginning to focus on these more basic areas in order to find cost-effective solutions to environmental problems.

I would like to focus on the last of these three factors and its impact on the evolution of waste management practice. It is important to understand that all three of these trends are interrelated and that any discussion of changing approach will also have a connection to the existing trends in standards and management philosophy.

In the field of waste management, there has been a historical focus on "end of the pipe" problems. This has, in part, stemmed from the fact that regulatory pressure has been directed towards the emission, waste or effluent that leaves an industrial property. Waste management systems have been developed to deal with the quality of an air or water emission from a plant with the characteristics of the effluent providing the key design parameter.

We are now beginning to understand that the sources of effluent contamination may provide us with some better alternatives for economic and effective waste management. This new focus on the source of contamination takes us away from the plant gate and back into the details of the various manufacturing processes that create the contamination. This approach to waste management may require a different type of knowledge to solve waste management problems than the technical knowledge of common waste management technology. The needs of the manufacturing process now become the focus of the waste management problem solver.

This may not be news to anyone that has been immersed in solving industrial waste management problems over the last few years, but there is little documentation of these problem-solving procedures in recent publications. This may be because of the nature of the problems themselves. We, and especially the public, have been conditioned over time to think of waste management problems as homogeneous problems that can be solved with simple methods.

We are urged to recycle, reduce, eliminate, reuse or otherwise manage these wastes with little understanding of the true nature of the individual problems. The problems in waste management often do not go away when these magic words are spoken. Each problem is a unique challenge in which "off the shelf" solutions are used with great caution.

Recognizing the individual nature of waste management problems, OWMC in 1986, began a process which would provide a procedure that could be applied to solve some of these waste management problems. The problem was easy to express but the solution proved to be very evasive.

We wished to create a manual which simply outlined a set of procedures to help with the cost-effective management of wastes in industrial plants. Since so many industries do not have the benefit of professional chemists and engineers to assist in the waste management area, we wished to create a manual which could be used effectively by people that understood their own processes, although they may not be familiar with waste management technology.

The development of this approach, although originally mired in the inability to speak of waste management issues in non-

technical terms, became a valuable exercise in understanding the best ways of applying some simple management techniques to provide an increased measure of environmental protection.

The objective of the manual project was to give industry some simple direction which would result in the improvement of their waste management procedures. The ultimate outcome should then be the reduction in the volumes of waste and contamination that will have to be absorbed in the environment or be treated or destroyed by waste management technology.

We wished to illustrate to industry the fact that many waste management techniques can actually provide a financial benefit especially in comparison to the cost of full BAT treatment.

We wished to help companies comply with the laws protecting our water and air.

Our last wish was to help industry understand and apply a hierarchical approach to waste management so as many resources as possible could be saved through reduction, reuse and recycling requiring only a minimum of treatment and disposal as the ultimate solution of waste management problems.

The focus of our work was to isolate on the production processes that generate the wastes to better understand the nature of the problems. In developing this greater understanding of the creation of the problems, there are often many more options presented to us for their solution.

Understand the root problems.

Isolate the sources of contamination.

Prioritize the problems.

Evaluate the options.

Make changes.

The Waste Audit and Reduction Manual (WARM)

The WARM was finally produced in 1987 after careful production and more important careful testing. The manual is 87 pages in length, but only the first 28 pages are used to provide the procedures. The remainder of the manual presents three case studies where practical examples of the use of these procedures are given. Case studies for a printed circuit board manufacturer, a steel pickling process and a detergent manufacturing process are used to enforce the principles explained in the manual itself.

The basis of the waste management procedures that are developed

stem from the application of material balance methodology from a slightly different perspective. Material balance methods are well developed for the determination of cost of production and for the isolation of cost problems within the industrial processes that exist in a manufacturing plant. The concept of material balance is pushed a little further to include the normal environmental problems associated with aqueous effluent, air emissions and solid and liquid waste streams.

The methodology consists of a six-phase approach. Each phase is necessary to develop an understanding of the movement and tracking of contaminants in the manufacturing processes and to get an understanding of the best options for economical waste management. The following is a brief account of the six phases in the WARM approach.

1. Understanding the Processes in Your Plant

The unit processes in the manufacturing facility are listed and then process flow diagrams are developed to understand the flow of materials amongst the processes. The level of detail required for this work can vary dramatically depending on the nature of the processes and the nature and location of the areas where contamination develops.

2. Defining Process Inputs

The raw materials and other resources required to perform each unit process are identified. Such things as storage and handling losses, water usage and material reuse are identified in this phase.

3. Defining Process Outputs

In a similar manner, process inputs are identified. Wastewater flows and waste removed for disposal must be included. Many of the outputs will be the inputs required for other processes.

4. The Material Balance Study

Information on the inputs and outputs to processes are assembled and preliminary material balance calculations are evaluated. At this time, it is frequently necessary to return and better define some of the process inputs and outputs to better establish material flows within processes. This refining process must be done to better prepare for the evaluation of management alternatives.

5. Identifying Waste Reduction Alternatives

Obvious waste reduction actions can frequently be

identified and implemented with little need for further technical evaluation. Areas can now be isolated to find the best place to target waste management effort. Long-term management strategies can be proposed for future effort.

6. Cost/Benefit Analysis and Implementing Action Plan

Careful evaluation of the cost/benefit of waste management alternatives are now conducted to optimize the waste management effort. When process or operating changes are implemented, the results should be an improved system of production efficiency and more effectively managed waste problems.

There has been a considerable amount of work done in the field of waste auditing. Most of this work has been oriented towards the issue of compliance with regulatory standards for treatment, disposal, air or water emissions. The WARM is a manual which has been designed to apply simple material balance methodology to the field of waste management in a way that can be understood by manufacturing process operators.

This type of methodology can be conducted at a simple level by operating personnel or at the other end of the spectrum by trained engineers delving into complex interactions of raw materials, processes and waste or at any level in between. OWMC hopes that the use of the WARM approach, supported by training and professional assistance, will be one more step in the improvement of waste management in Ontario.

The Waste Audit and Reduction Manual can be purchased from the ONTARIO WASTE MANAGEMENT CORPORATION for a cost of $ 25.00 per copy.

ONTARIO WASTE MANAGEMENT CORPORATION
2 Bloor Street West
Toronto, Ontario
M4W 3E2
Telephone 416 923 2918 (Toronto) or 1 800 268 1179
Fax 416 923 7521

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OVERVIEW OF THE CAP PROGRAM (REGULATION 308)

by
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Toronto

A review of the Province of Ontario's air management program was commenced in 1983. At this time, a comprehensive survey of the existing program was initiated - identifying the component parts, their individual roles and interrelationships.

A recognition of the pivotal importance of Regulation 308 Air Pollution - General stemmed from the comprehensive review process and it was decided to examine it in detail in order to suggest possible amendments. To this aim seven committees were struck within the Ministry of the Environment to examine specific aspects of the regulation in detail. These committees took varying amounts of time to produce final reports - the group charged with the responsibility for examining the modelling provisions of the regulation (which was combined with the group looking at long range transport of air pollutants) took over a year and several meetings to complete its task whereas others such as the one with responsibility for reporting on the provisions in the current regulation relating to the Air Pollution Index and the possible consequence of adding the proposed Air Quality Index held only one meeting and was finished its task in a matter of weeks.

Following the production of the committees' reports, it was decided to hold a workshop to expose the findings to a wider audience and to seek input as to possible directions for further study of the Regulation. A workshop was held in November, 1985 with an invited audience representative of the wide spectrum of interests in the regulation. At this workshop the Ministry made presentations on key areas such as modelling; there were sessions on the specific sections of the regulations; and plenary sessions at which reports from the workshop sessions were presented by the workshop chairmen and to which the audience was encouraged to add further comments. A transcript of the plenary sessions was made and summaries of the workshops produced from the secretaries' notes. These were published and made available to participants and others on the Ministry's mailing lists. They have also been reproduced in the documents associated with the present stage of the initiative (Appendix G).

Stemming directly from the workshop there was a request for a further specialized meeting to discuss the modelling proposals. This was held in April, 1986. Proceedings of this meeting were also produced and these are also available in the documents associated with the discussion paper (Appendix G).

Using the proceeding of the workshops , further inputs from correspondents and internal ministry discussions, staff then started to put together the proposals, now known as the Clean Air Program (CAP). These proposals were released for public review in November 1987 and the Minister indicated that comments would be welcomed.

THE CAP PROGRAM

The CAP program has as its cornerstone a recommendation that the Ministry should abandon the existing system of evaluating emissions to the atmosphere which uses point of impingement models. In its place, a system which mandates minimum levels of emission control based on the

nature of the contaminants being emitted and the availability of measures to control them, combined with the use of a more comprehensive, state of the art package of models for establishing probable attainment of satisfactory air quality, is recommended. It is suggested that levels of satisfactory air quality should be stated as legally enforceable standards, and that such standards should be set by a committee with some form of public representation.

In the discussion document two schemes for establishing appropriate levels of control technology are presented - a two level scheme and a three level scheme. For both schemes, it is suggested the decision on the appropriate level of control should be based on a contaminant scoring system which takes account of various characteristics of contaminants. The parameters which might be incorporated into the system are toxicity (carcinogenicity, mutagenicity, lethal and sublethal effects), mutagenicity, persistence/bioaccumulation, and transportability from one environmental medium to another. A tentative set of combining rules for adding the scores for the various parameters is presented in the proposals. It is suggested that the group of contaminants with the highest scores would require a very high level of emission control - this level is identified in the proposals as Lowest Achievable Emission Rate (LAER) - the U.S. designation for controls required on new sources in non-attainment areas - although the required level of technology suggested is that equivalent to the best proposed or in operation anywhere in the world. The second category is identified as Best Available Control Technology - Economically Achievable (BACT-EA) - the U.S. nomenclature used for controls required on new sources in attainment areas. Again, although in evolving the required emission rates U.S. determinations would probably be used, a slightly different definition is contained in the proposals to ensure industry economics rather than plant economics are used. The third category of control suggested is identified as New Source Performance Standards (NSPS) or Reasonably Available Control Technology (RACT) - the U.S. minimum requirements for new or modified specific categories of source in all areas, and for existing sources in non-attainment areas respectively. A somewhat lower minimum level of control is indicated for this category with a heavy emphasis on what is economically appropriate down to the individual plant level.

In its proposals the Ministry of the Environment has identified a number of mechanisms by which maximum emission rates might be identified and used under this system. It is suggested that the actual work of evolving the appropriate limits could be undertaken by proponents using Ministry guidelines; by the Ministry; or by representative committees working on an industrial sector approach. The limits themselves might be stated in terms of actual mandated control technologies with set emission restrictions; percentage removal established by contaminant class; or as emission limits (per unit of product or concentration in the exhaust gases).

Under the CAP proposals, once a proponent has selected the appropriate control technology there is a requirement to input critical parameters into dispersion models to prove that the second line of defense, a satisfactory level of ambient air quality (as defined by air quality

standards), will be achieved. The models which the Ministry is currently advocating for use in Ontario are included in a new model package. This package attempts to take account of the the full range of meteorological (dispersion) conditions found in the Province of Ontario and to incorporate state of the art models suitable for regulatory use.

Another fundamental change being proposed under CAP is that certificates of approval (to construct a source of contaminant emissions to the atmosphere) should be replaced by two part certificates - to construct and operate - and that the operational sections should be renewable. Currently, certificates of approval are issued with no expiry date, and provided no change is made to the facility are without recall - leaving the Ministry with measures such as Section 126 (Provincial Officers') Reports and subsequent Control Orders as the only remedial measures. The proposals suggest that proponents should be required to obtain a certificate to construct and operate, and that the latter part should be renewable. Currently, it is being suggested that the renewal period should be every ten years. This would enable the Ministry to ensure that adequate control of emissions is being maintained and, particularly in the case of sources of contaminants deemed to be potentially harmful, that controls are updated on regular basis in line with latest developments.

Among the conditions which it is anticipated might be included on the operational part of the proposed certificates of approval to construct and operate are indicators of system performance - these could include continuous emission monitoring, minimum stack temperature, pressure drop across baghouses etc. It has also been proposed that where deemed necessary that ambient monitoring might be required.

In addition to these proposals for change which will affect the certificate of approval process the CAP proposals also deal with the subject of visible emissions. In reality the Ministry has been using an equivalent to the Method 9 method of determining opacity rather than the Emission Density Chart referred to in the existing regulation. The Ministry is proposing therefore to include the Method 9 approach in the revised regulation.

IMPLEMENTATION PROPOSALS

It is recognized that profound changes, such as are being proposed in CAP, will require a careful and lengthy phasing in period. The modelling package, subject to whatever changes result from the ongoing discussion process, is currently fully operable for single sources and simple source situations. Necessary background ambient air quality data however are not yet available for many contaminants. These will have to be obtained by proponents, perhaps during the planning process, or will have to be generated by the Ministry's Air Monitoring Program. The evaluation of contaminants on the other hand, even if the scoring system proposed is adopted as presented, is not well advanced. At this point in time, only a limited number of common air contaminants have been scored (in connection with other Ministry initiatives). Complete

scoring of the remaining contaminants will take considerable time, although, by using abbreviated screening searches of the literature it will be a relatively easy task to evolve a scheme for prioritizing the process.

Under the proposals as written, it is anticipated that all existing and new LAER and BACT-EA contaminant sources will be brought into compliance with the proposed regulation through the certificate of approval to operate mechanism within five years of promulgation of the regulation. During this time a number of situations will probably occur requiring special consideration. These include: changes to existing operations requiring new certificates of approval where improvements in air quality will result; facilities which have received certificates of approval to construct but have not reached the point of operation; facilities subject to Control Orders; proposals for new/changed facilities in noncompliance areas; sources of small emissions or small quantities of environmentally significant contaminant(s) in large innocuous gas streams; situations where modelling indicates that intermittent control might be required under certain meteorological conditions; and situations where modelling indicates the potential for a small number of inconsequential annual exceedances. In all these areas the Ministry has sought to anticipate and recognize the genuine concerns of industry while retaining the integrity of the proposals. Accordingly, the following suggested courses of action are included in the proposals:

° provided a valid approval is in force, no exceedance of existing standards is indicated, LAER contaminants are not involved, and a net air quality improvement will result, an automatic triggering of a full plant reapproval requiring upgrading of all emission control technology and use of the new ambient air modelling system, should not be required

° where approval has been obtained but construction has not been completed at the time of promulgation, facilities emitting BACT-EA or LAER contaminants would only be able to proceed after a review by the Director indicates that the control technology being used is consistent with the intent of the regulation

° in noncompliance situations where Control Orders are issued these should reflect the new regulation immediately upon promulgation

° in cases where more than one operation is deemed to be responsible for a problem situation the burden of control should be shared among all the contributing sources

° no new sources deemed likely to exacerbate an existing noncompliance situation would be approved

° the Ministry of the Environment recognizes the need to write an exemption, probably in the form of guidelines, for small sources of a single contaminant and complex sources containing traces of specific contaminant(s) known to have a very significant environmental effect - three approaches, an emission cap, a concentration limitation approach which assumes a very conservative dispersion factor, and a combination approach are examined in the proposals

- intermittent control systems are acknowledged as a sound way of dealing with intermittent, meteorologically based noncompliance situations, and under specific conditions are suggested as a means of overcoming possible problems indicated by the modelling

- to prevent the approval process being driven by overly conservative modelling, it is proposed that for non-acutely toxic emissions with a one hour (or less) standard that the eighth worst predicted hourly value (99.9 percentile) should be used.

THE PUBLIC REVIEW PROCESS

Following release of the proposals, in order to improve circulation and understanding of the CAP program, Ministry staff held 20 public meetings - each consisting of an informal afternoon session, and a more formal evening session with a question period; meetings with 11 industry groups and 3 other government groups; and an open workshop. Proceedings of all of these meetings were recorded and it is intended to incorporate these into the comments received on the proposals.

In the next stage of the program, it is anticipated that the submissions made to the Ministry will be reviewed in detail and that a response document, outlining the various groups' concerns, together with the Ministry's position, will be produced. This document will be published. Concurrently, the Ministry is producing an economic evaluation of the proposals which will be submitted to Cabinet prior to, or together with a Draft Regulation. The Draft Regulation will be published and subject to a public comment period of at least 45 days.

It should be emphasized that regardless of the fixed points in this timetable that the Ministry; continues to welcome comments on its proposals at any stage in the proceedings. A firm commitment to public involvement is an integral part of the program since the Ministry firmly believes that consultation results in better legislation. Certainly, the process to date indicates that this approach is justified in terms of the number and quality of comments received, and it is anticipated that this will translate into an equitable set of rules which will guarantee the preservation of Ontario's air quality.

IMPLICATIONS OF PROPOSED REGULATION 308 ON INDUSTRY

by
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1. INTRODUCTION

The Clean Air Program (CAP) introduced by the Ontario Ministry of the Environment in November 1987 proposes a major shift in the principles and practice of air regulation in Ontario. In order to begin implementation of the CAP, the OME has developed a discussion document which outlines a program for the revision of the General Air Regulation (the current Regulation 308), and has allowed a four month period ending in April 1988 for responses to this document from industry and concerned citizens. Following review of the responses, the Ministry will draft a new regulation.

The objective of this paper is to summarize, albeit in a very cursory manner, the major implications on industry in Ontario of the proposed revision, to the extent that these have been identified at this point. The summary draws on the initial analyses carried out by a number of industrial sectors, and available to me through my involvement with their deliberations. It will also be clear from the following that the short time frame available for response, as well as the vague nature of the proposals have prevented the carrying out of economic impact analyses of even a preliminary nature. For this reason, the major issues addressed in this paper, as well as in the industry responses, deal with regulatory feasibility and only secondarily with the issue of the economic burden on industry.

2. SCOPE OF CAP PROPOSAL

The discussion document proposes three major shifts in the way in which air quality is regulated in Ontario:

i) a level of emissions control will be mandated for each industry (the mechanism for defining the level is not determined at this time) and will constitute a requirement for all facilities without regard to the state of the air quality in the region.

ii) a greatly expanded list of controlled contaminants, together with a classification scheme which would determine the level of concern for the contaminant in terms of health and vegetation impacts. The toxicity classification would be used in imposing the appropriate control option.

iii) a total airshed approach to the permitting of air emissions, as a second level of control. This would require that any applicant for a permit first include the most stringent level of control as appropriate for the contaminant and the industry sector, and then determine the combined impact of all sources in the airshed, with the new source included, by the use of mathematical dispersion modeling. Should the total impact exceed the appropriate standard, the proponent would be required to determine what additional measures would bring about compliance of the total airshed.

The thrust of the revision is seen to be along several directions: firstly, the traditional alternative of dispersive control of ground level concentrations as the primary mechanism will no longer be acceptable as a control measure; the expanded contaminants list is intended to bring more facilities within the scope of the air regulation; and the proponent will not be evaluated in isolation as is presently done, but must demonstrate

compliance of the airshed as a whole with mandated air quality standards.

Although the discussion document addresses many of the provisions which the new regulation will encompass, it leaves a number of issues completely open and some of the others in the form of alternative options. For example, the document implies that the revision of Regulation 308 is only one component of the CAP program; however, there is no indication of the other significant changes being contemplated. Since some of the airshed provisions of the CAP necessarily implicate sources which are not subject to Regulation 308, it is crucial that the full scope of the changes be known in order to produce a well founded assessment. Thus, if some of the perceived problems of the revised regulation are dealt with in the unannounced components of CAP, it would have been very useful to be aware of these in formulating the response.

Options left open at this stage include the choice of two or three levels of control technology along with the ranking of each of the substances on the prescribed list of 250 contaminants. Since this classification is crucial to determining potential process and control equipment requirements, this ambiguity can of itself prevent the development of an economic impact assessment of the regulation.

Although a preliminary assessment of the scope of the regulation can be obtained from the available information in the discussion document, it is to be expected that many of the implications are not clearly understood at this time. This results primarily from the lack of familiarity with this type of regulatory approach both within industry and the Ministry. The U.S. is still in the process of resolving some of the issues after it introduced a regulatory framework along these lines (but of much narrower scope) some years ago.

3. IMPLICATIONS OF PROPOSED REGULATION

Environmental Quality

It is an accepted proposition both by Industry and the Ministry that the imposition of control of emissions at source will lead to better air quality than is presently achieved using a combination of source control and dispersion. This is based on the adage that "what goes up must come down". It should not be forgotten, however, that what doesn't go up can also end up in the environment in the form of liquid effluent and solid waste. The discussion document does not address the issue of the impact on the total environment of industrial and other activity, and therefore cannot make the claim that the environment on the whole will be improved. The proposal also fails to deal with the question of other contributing sources, such as mobile and roadway emissions, and influx from other jurisdictions. For some locations and some contaminants these sources will far outweigh the regulated sources, so that no demonstrable benefit to the environment will result from controlling the industrial sources.

The airshed approach to permitting, if not comprehensively applied through a planning process, can lead to disincentives to additional source control beyond the minimum necessary to meet the air quality standard. This results when a source of emissions is forced to maintain a historically obtained share of the airshed for purposes of future expansion.

These considerations do not invalidate the approach being proposed; however, they point to the need for a more thorough assessment of the overall implications of the proposal within the context of the actual situation, taking full account of all contributing sources and all compartments in the environment.

Continued Operation of Industry in Ontario

The approach to air emissions permitting suggested in the Discussion Document creates the real possibility that some industrial installations will be shut down in Ontario. This results from a combination of the two requirements that all existing installations must be relicensed under the new regulation within a fixed time interval after promulgation (presently suggested as five years) and that they demonstrate compliance of the total airshed with the standards. Where the present air quality is in violation of the proposed standard even in the absence of the proponent source, as is the case for suspended particulate in Southwestern Ontario where the industrial sources are not the major contributors, the only case for which approval to continue operation would presumably be given would be that of zero emissions of the contaminant.

A similar situation faces the installation which, after the incorporation of the mandated control equipment, still cannot demonstrate compliance with the standard. This can happen because the standard is very stringent, for example, the silica standard can be exceeded by background sources alone, or because the models tend to over-estimate the impact of the source on the ground level concentrations, or a combination of the two. The present proposal does not adequately recognize the inherent conservative nature of the models. Thus, even where measurements might demonstrate compliance with the standard, the model results take precedence in evaluating compliance for permitting purposes.

The failure to provide within the proposed regulation of a requirement on the Ministry to produce compliance plans for an airshed can have the same effect. For example, the applicant may fail to demonstrate compliance with the standard because of the superposition of other sources in the airshed; however, he may be using the existing emissions values for the other sources which have not yet been relicensed, rather than controlled emissions which will be in effect at some point in the future. A similar situation exists where present monitoring data are used to

demonstrate future compliance. If the Ministry had a total compliance plan for the airshed, this situation could be resolved.

Another provision which would have the effect of shutting down an installation is the proposed principle that "it is unacceptable to emit chemicals about which little or nothing is known", that is, those which have not yet found their way into the contaminants list. Thus, if some trace substances co-emitted in the smelting process are labelled as chemicals, for which no standards have yet been assigned, then the smelter must cease operation pending the execution of all the necessary studies into the effects of the substance.

Maintenance of Competitiveness Internationally

In order to stay competitive in an international market, particularly in anticipation of the Free Trade Agreement with the U.S., industry must be able to maintain or reduce costs as well as plan for growth. Both of these will be affected by the proposed regulation. Although the vagueness of the proposal and the limited response time have not provided sufficient opportunity for industry to address these questions adequately, it is possible to single out some of the obvious problems.

The principal problem is the introduction of provisions which create a large amount of uncertainty in terms of future requirements which will be imposed on the facility. Chief of these is the requirement to renew the C of A every ten years, with the intention of requiring the installation to implement the best control technology which is available at the time of renewal. However, because the modeling approach may also have been changed in the interim, and because the airshed may have become used up by other sources whether regulated or not (for example mobile sources, exempted sources, or background influx), the renewal could be denied. The fact that the airshed, as well as the models used for determining compliance will be undergoing changes with time also means that plans for growth cannot be made with any reliability.

If industry needs to build in contingency factors to cover such uncertainty in the future, the cost of doing business will be inflated, with the result that the Ontario industry loses its competitive advantage in the long run. We could then become importers of the commodity as well as the more polluted air from our neighbours.

4. INDUSTRY CONCERNS WITH PROPOSAL

The industry responses to the discussion document address all of the issues which are contained in the document, and it appears that there is broad agreement among the responses in terms of how industry perceives the development of the regulation. In the following, some of the key points made by industry are discussed.

Source Control

Industry supports the concept of control at source (bottom of the stack) as the prime means of maintaining ambient air quality. It is concerned, however, that the Ministry approach appears to call for "control for control's sake", even where no demonstrable problem exists. If the concern is with toxics, then why not restrict the relicensing of existing facilities to the toxic class of substances only. Where problems still exist in the traditional pollutants such as sulphur dioxide, the Ministry still retains the control order approach to enforce additional controls. In terms of mechanism, industry prefers the setting of emissions limits, with each industry developing its own strategy for meeting the mandated emissions limits.

De Minimis Criteria

The concept of qualifying a source under a de minimis clause, as a means of reducing the burden on very small installations, is considered a good measure. Under the proposal, however, these sources are not exempt from the airshed requirement of modeling, which in itself can negate any perceived benefit of the exemption. In order to make the concept workable,

the de minimis application could be treated as an exemption, which would have a different evaluation process from the C of A (Certificate of Approval) stream. The concept of making the de minimis criteria specific to the airshed would provide more flexibility in permitting in non-industrialized airsheds, while allowing for a more stringent requirement in highly populated and industrialized airsheds.

Airshed Approach

The airshed approach to permitting, because of the unresolved status of the proposal as discussed above, and the many potential problems in the implementation of such a concept, does not find unequivocal support in industry. As a minimum, in order to make the concept workable, the proposed regulation will need to address the issues of:

permitting in airsheds which are in **non-attainment** (i.e. where measured concentrations exceed the standard) at present, including the problem of apportionment of the airshed,

provision of **monitored data** on air quality with respect to the large number of contaminants,

adoption of the principle that monitored data can over-ride the results of modeling for purposes of permitting,

the requirement for a workable and tested regulatory modeling package,

provision of an **off-set scheme** which would permit industrial growth,

a **planning process** which can take into account the projected changes in an airshed, in order to provide the needed mechanism for evaluating licensing applications.

Classification of Contaminants

The ranking of contaminants is generally considered desirable, although the use of a toxicity scoring system is considered too simplistic for the complex questions being dealt with. As an example, in the final evaluation, the carcinogenic impacts are given the same priority as the phytotoxic impacts, which is probably not the Ministry's stated objective.

Standard Setting

There is a general disagreement with the Ministry's philosophy for setting ambient air standards. It is felt that standards should be set only for those substances which are known to, or have the potential to, exist in the environment in sufficient concentration to pose a risk. A standard should be set and the substance included on the contaminants list only when sufficient information has been obtained and documented, and where a consensus of expert opinion (including the Ministry, Industry, and the Public) has determined the standard.

Implementation Proposal

The strongest disagreement with the proposal is in the area of implementation of the new regulation. It is widely felt that the C of A procedures must be made more workable through several measures: a C of A could be issued for the entire installation, rather than piecemeal, thus making planning possible and reducing the burden on both the proponent and the Ministry; although a two part C of A is workable, it must contain a procedure for obtaining both parts before the new installation is constructed, in order to preclude the use of the C of A as a coercive mechanism; the Ministry must undertake to evaluate an application within a fixed time-frame.

Modeling Provisions

The modeling proposal, as presented in the discussion document, is not sufficiently developed, or tested at this time. For example, the Air Resources Branch is still in the process of making significant changes to the model code, the last being at the beginning of May. Since the new

models show large departures in terms of predicted maxima by comparison with the existing Regulation 308 models, this issue is in critical need of resolution before the regulated community can accept the models. Even more critical is the intended method for the use of the models. In the proposal, the model provides the final decision on the acceptability of a submission for C of A. Recognizing that the models are by construction conservative, the Ministry must develop a procedure for reconciling the model predictions for an airshed with the monitored data.

Regulation Development

There is a consensus within the industry responses that **the next phase in the process of developing the revised regulation cannot be the drafting of the regulation**. It is felt that neither the Ministry nor Industry have had sufficient opportunity to assess the full implications of the proposal or to carry out the necessary dialogue. On the basis of the industry responses, it is now possible to arrive at a more definite discussion document, which could be subjected to economic and other analysis through an open consultative process among the Ministry, Industry and the Public. Following this analysis, the Ministry would be in a position to draft a regulation which would be acceptable to all parties and serve the interests of protecting the environment as well as maintaining a viable industry in the province.

FLUOROCARBONS AND THE OZONE LAYER

by
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United Nations Environment Programme (UNEP)

MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

1987

HISTORICAL PERSPECTIVE

early 1970s	First concerns about the ozone layer (NO_x emissions from supersonic transporters)
June 1974	Ozone depletion theory (Rowland and Molina)
March 1977	UNEP establishes CCOL
May 1977	UNEP Governing Council adopts the World Plan of Action on the ozone layer
March 1980	Canada prohibits the use of CFCs in hairsprays, deodorants and anti-perspirants
May 1981	UNEP initiates international negotiations aimed at the elaboration of a global convention to protect the ozone layer
22 March 1985	VIENNA CONVENTION for the Protection of the Ozone Layer signatories: 20 countries + EEC (10 countries)
4 June 1986	Canada is the first country to ratify the Vienna Convention
16 Sept. 1987	MONTREAL PROTOCOL on Substances that deplete the Ozone Layer signatories: 24 countries + EEC (12 countries)

KEY FEATURES
of the
MONTREAL PROTOCOL

1. SCOPE Group I (CFC): 11, 12, 113, 114, 115
Group II (HALON): 1211, 1301, 2402

2. CONTROL MECHANISM C = P + I - E

3. CONTROL PLAN #short term: A) mandated freeze (HALON)
B) mandated phasedown (CFC)
- freeze
- 20% reduction
- 30% additional reduction
#long term: periodic review (every 4 years)

4. TRADE SANCTIONS (Non-Parties)
(a) "bulk" regulated substances
(b) products containing (a)
(c) products manufactured with (a)

5. EQUITY CLAUSES
(a) developing countries (0.3 kg per capita)
(b) U.S.S.R. (5 year plan)
(c) small producers (25 kt)

6. ENTRY INTO FORCE
criteria: 11 ratifications
2/3 global 1986 production

date (anticipated): 1989-01-01

SCHEDULE

1989	Entry into force of the Protocol [article 16] (anticipated date: 1989-01-01)	
1990	EIF+6m. - EIF+18m. freeze (1986): consumption CFC P ⩽ 1,10P (1986)* [article 2.1] assessment of control measures [article 6]	EIF+1 year ban imports of CFC/HALON from non-Parties [article 4.1]
1991		
1992	EIF+36m. - EIF+48m. freeze (1986): consumption HALON P ⩽ 1,10P (1986)* [article 2.2]	EIF+3 years list of products containing CFC/HALON [article 4.3]
1993	January 1, 1993 exports of CFC/HALON to non-Parties no longer accounted for in calculations [article 3.c]	January 1, 1993 ban exports of CFC/HALON to non-Parties [article 4.2]
1994	July 1, 1993 - June 30, 1994 consumption CFC ⩽ 80% C (1986) P ⩽ 1,10P (1986)* [article 2.3] assessment of control measures [article 6]	EIF+5 years control imports of products manufactured with CFC/HALON from non-Parties [article 4.4]
1995		
1996		
1997		
1998	assessment of control measures [article 6]	
1999	July 1, 1998 - June 30, 1999 consumption CFC ⩽ 50% C(1986) P ⩽ 1,15 P (1986) [article 2.4]	

* needs of developing countries / rationalization

IMPLEMENTATION PLAN

PHASE ONE
- Promulgation of CEPA
- Ratification of the Montreal Protocol
- Control Options Report-I (May '88)
  # to meet the Protocol's requirements
  # "Quota system"

PHASE TWO
- "Further and Faster"
- Control Options Report-II (December '88)
  regulatory impact analysis
- Proposed regulations (Early '89)

CFC AND HALON CONTROLS UNDER CEPA

TIMETABLE FOR KEY ELEMENTS

MAY 1988
- Promulgation of CEPA
- Ratification of Montreal Protocol
- Control Options Report - Phase I - released May 15 - options to meet Protocol requirements)
- SKEW Report - Part #1 released (industry structure)
- Sole source contract to ABT consultants for SEIA on control options (Phase I) (they will continue work on RIA for selected Phase I option)

JUNE 1988
- CFC and Halon Use Pattern in Canada (EC survey report released - 1986 reference levels)
  Let contract for preparation of Phase II Control Options Report
- Let contract for Use Pattern-Product Survey

JULY 1988
- SKEW Report Part 2 is released. (Detailed analysis of alternative chemicals, products, recycle etc.)
  Comments on Phase I Control Options Report received and processed
- Contract let for Phase II Control Options Report SEIA

AUGUST 1988
- Senior management/Minister's briefing, etc.
- Decision required on selected option - Phase I
  Product Survey Report released (background data for regulation development under Phase II)

SEPTEMBER 1988:
- Canada Gazette, Part I - Selected Control Option - Phase I
- RIA (for selected Control Option Phase I) released (Part 2 of ABT study shown under May 88)

OCTOBER 1988
- Comments on Canada Gazette Part I - (selected - Phase I Control Option) received and processed
  Control Options Report - Phase II (products, etc.) released
- SEIA on Control Options Report - Phase II - released

NOVEMBER 1988:
- Consideration of appeals
- Ministerial decision

DECEMBER 1988:
- Canada Gazette Part II on selected Phase I Control Option

JANUARY 1989:
- Entry into force of the Montreal Protocol
- Canada Gazette Part I on Phase II Controls

JULY 1989:
- Freeze at 1986 levels takes effect.

Phytotoxicology Aspects of Soil Lead Clean-up Programs in the Vicinity of Secondary Lead Smelters

by

R. J. Rinne, Air Resources Branch,
Environment Ontario, Toronto

Background

The Phytotoxicology Section of the Air Resources Branch has been involved in the issue of soil lead contamination near secondary lead smelters since the early 1970's. In 1976/77, relatively minor soil lead clean-up programs were conducted in the vicinity of the Canada Metal Company (CMC) on Eastern Avenue in the South Riverdale area of Toronto, and Toronto Refiners & Smelters (TRS) at Bathurst and Niagara Streets in Toronto. In these instances, soil on 48 residential properties near CMC and 7 properties near TRS which had more than 2600 ug/g (ppm) of lead, as identified by Phytotoxicology Section testing, was replaced to a depth of 15cm (6"). The level of 2600 ug/g (3000 ug/g minus an error factor) was recommended by the Environmental Hearing Board which was established to investigate the issue of lead contamination in Toronto. The Board issued its report in April, 1976.

Recent History

Many residents were not satisfied with the 2600 ug/g soil replacement criterion, and they continued to express this concern, individually and through groups such as the South Riverdale Community Health Centre, the Niagara Neighbourhood Association, and more recently, the Sherway Ratepayers Association (vicinity of the Tonolli Company of Canada Ltd., a Mississauga secondary lead smelter).

At the principal instigation of South Riverdale residents associated with the Community Health Centre, the Minister of the Environment in early 1987 announced the formation of a Lead in Soil Committee, with representation from industry, local residents, and municipal, provincial (including the Phytotoxicology Section) and federal governments, to re-examine soil lead guidelines. The Committee recommended in its report dated May 1987, that the residential soil lead guideline should be between 500 and 1000 ug/g, for areas near lead smelters where children have elevated blood lead. Concurrent with the public release of this report the Minister of the Environment announced in June, 1987 that soil removal would be conducted in residential neighbourhoods near secondary lead smelters, where children have elevated blood lead levels, and soil lead levels are 500 ug/g or more. Replacement depth was set at 30cm.

Rationale for a 500 ug/g Soil Replacement Guideline

Although a direct effect of 500 ug/g soil lead on elevated children's blood lead has not been demonstrated, the following points of information could be used to justify a 500 ug/g residential soil replacement guideline for lead:

- the Phytotoxicology Section "upper limit of normal" lead concentration in urban Ontario surface soils is 500 ug/g .

- the maximum recommended application of lead to soils used for growing fruits and vegetables in the U.S. is 400 ug/g.

- officials of Health and Welfare Canada have stated that lead concentrations higher than 0.5 ug/g in fresh fruits and vegetables may pose a potential danger to health from long-term consumption.

- Phytotoxicology Section data have shown that 0.5 ug/g lead in fresh vegetables can be encountered at soil lead levels of 400-500 ug/g.

- 500 ug/g soil lead has been reported to be toxic to tree seedlings.

- a soil clean-up guideline of 550 ug/g lead has been recommended for home gardens in Great Britain.

Current Situation

South Riverdale (Canada Metal Company)

Soil testing conducted since 1985 by Phytotoxicology Section staff and by consultants retained by Central Region MOE have revealed 882 residential properties with surface soil lead concentrations at or above 500 ug/g located within the designated blood lead testing area (designated soil replacement area - see Figure 1) of South Riverdale. The total number of residential properties sampled was 1150. The maximum residential lead level measured was 11,000 ug/g (parking area).

The protocol which was established to determine which properties were eligible for soil replacement, based on the results of soil testing, is shown in Figure 2.

Figure 3 depicts the trend of decreasing soil lead levels with increasing distance from CMC, for residences on a street north of the company.

Results of random soil profile (depth) sampling are illustrated in Figure 4. Soil lead concentrations usually decrease with increasing depth.

Soil replacement was conducted on 69 properties in late 1987. The remainder of the work is underway at the present time and is scheduled for completion during 1988. The total cost of the replacement program, including house dust cleaning, is expected to approach $10,000,000.

Based on the results of Regulation 309 leachate testing, only four properties contained material unsuitable for disposal at a sanitary landfill site.

An inventory of commercial/industrial properties within the designated area of South Riverdale has been completed by the consultant. Decisions on further action (soil sampling, replacement) on commercial/ industrial properties are pending.

Niagara Neighbourhood (Toronto Refiners & Smelters)

In July 1987, Toronto City Council wrote to the Minister of the Environment requesting that the MOE do soil testing and replace all soil with greater than 500 ug/g lead on residential and other publicly accessible sites located within 300m of Toronto Refiners and Smelters (see Figure 5). Subsequently, in October, 1987, the Minister of the Environment announced that a soil removal program in the Niagara Neighbourhood, similar to that currently underway in South Riverdale, would commence in 1988. In response, the Phytotoxicology Section was directed to carry out extensive soil testing in the vicinity of the smelter during late 1987.

The results of the soil testing revealed that 125 of 161 residential properties within the designated soil replacement area had surface soil (0-5 cm depth) lead concentrations of 500 ug/g or higher. The maximum residential lead level measured was 4450 ug/g (backyard garden). Of 136 publicly accessible sites sampled, 66 had soil lead levels of at least 500 ug/g (maximum 64,500 ug/g).

A contract has recently been let by Central Region MOE for additional soil sampling (sub-surface verification and Reg. 309 leachate sampling) and soil replacement. The work is to commence during the summer and should be completed this year. Anticipated costs are two to three million dollars (including house cleaning).

Mississauga (Tonolli Canada Ltd.)

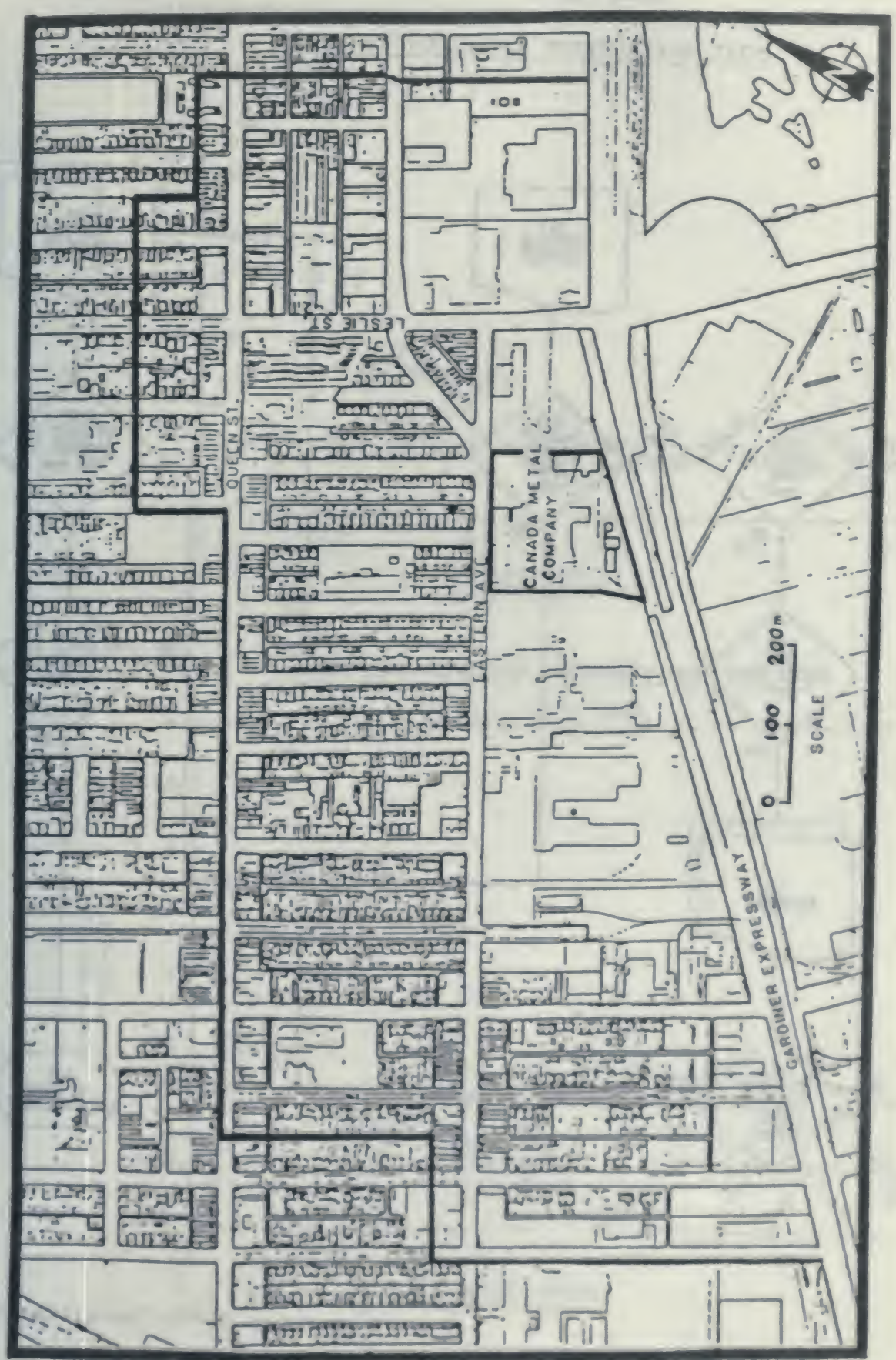
In response to requests from local residents and Peel Region Public Health Department authorities, staff of the Phytotoxicology Section conducted extensive soil sampling on residential, public and publicly accessible commercial/industrial properties in the vicinity of Tonolli Canada Ltd., in the Dixie Road, Dundas Street area of Mississauga in 1987 (see Figure 6). The intent of the sampling was to identify all properties that had soil lead concentrations of 500 ug/g or higher.

The results of the soil testing determined that, of 296 residential properties sampled, 74 had surface soil (0-5 cm depth) lead levels greater than or equal to 500 ug/g. The maximum soil lead concentration measured on a residential property was 2800 ug/g (boulevard).

Fifty-one of 95 public and publicly accessible commercial/industrial sites had soil lead levels greater than or equal to 500 ug/g (maximum 39,000 ug/g).

These findings have been reported to the Peel Region Department of Public Health. Officials of this Department currently are examining the results within the context of their own blood lead testing results, and are expected to make recommendations for soil removal shortly. Soil removal will likely be conducted during 1989.

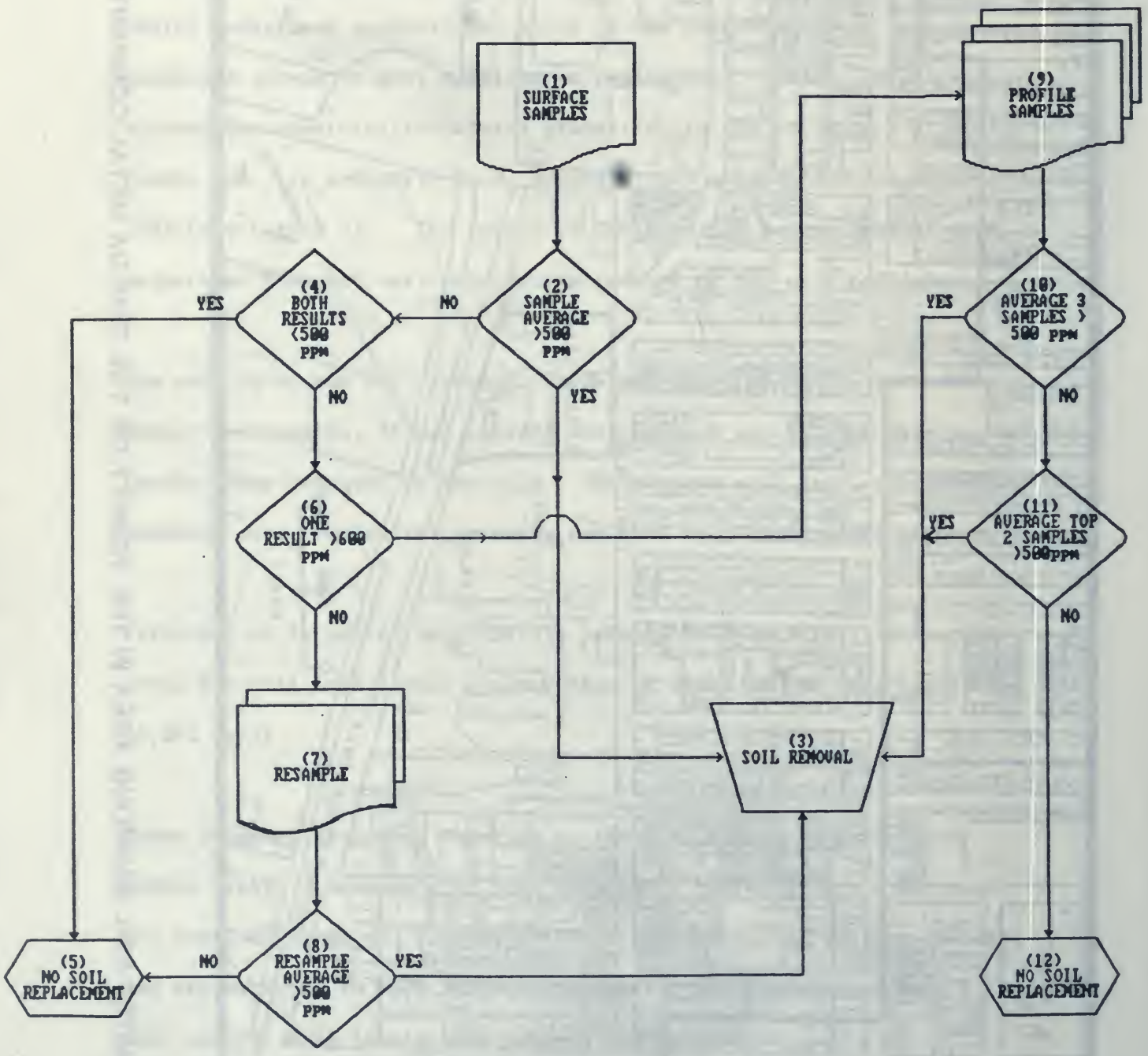
(Figure 1)



DESIGNATED SOIL SAMPLING AREA IN THE VICINITY OF THE CANADA METAL COMPANY

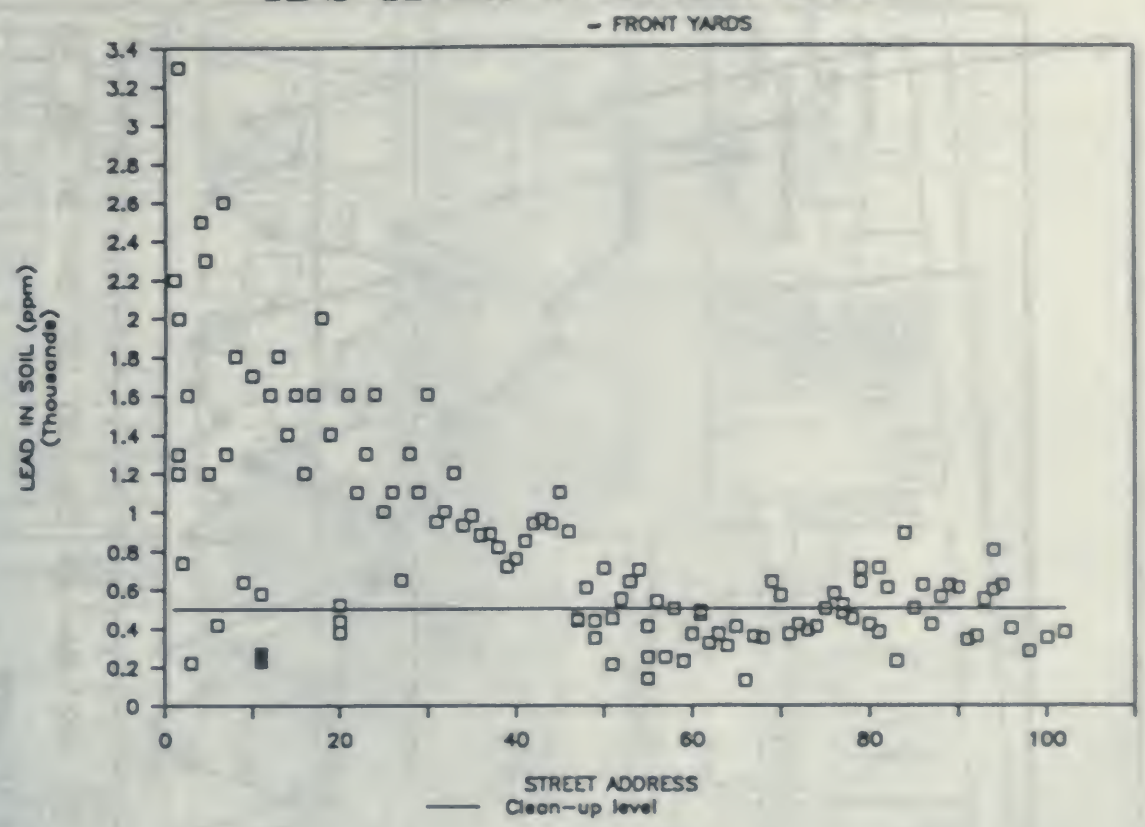
(Figure 2)

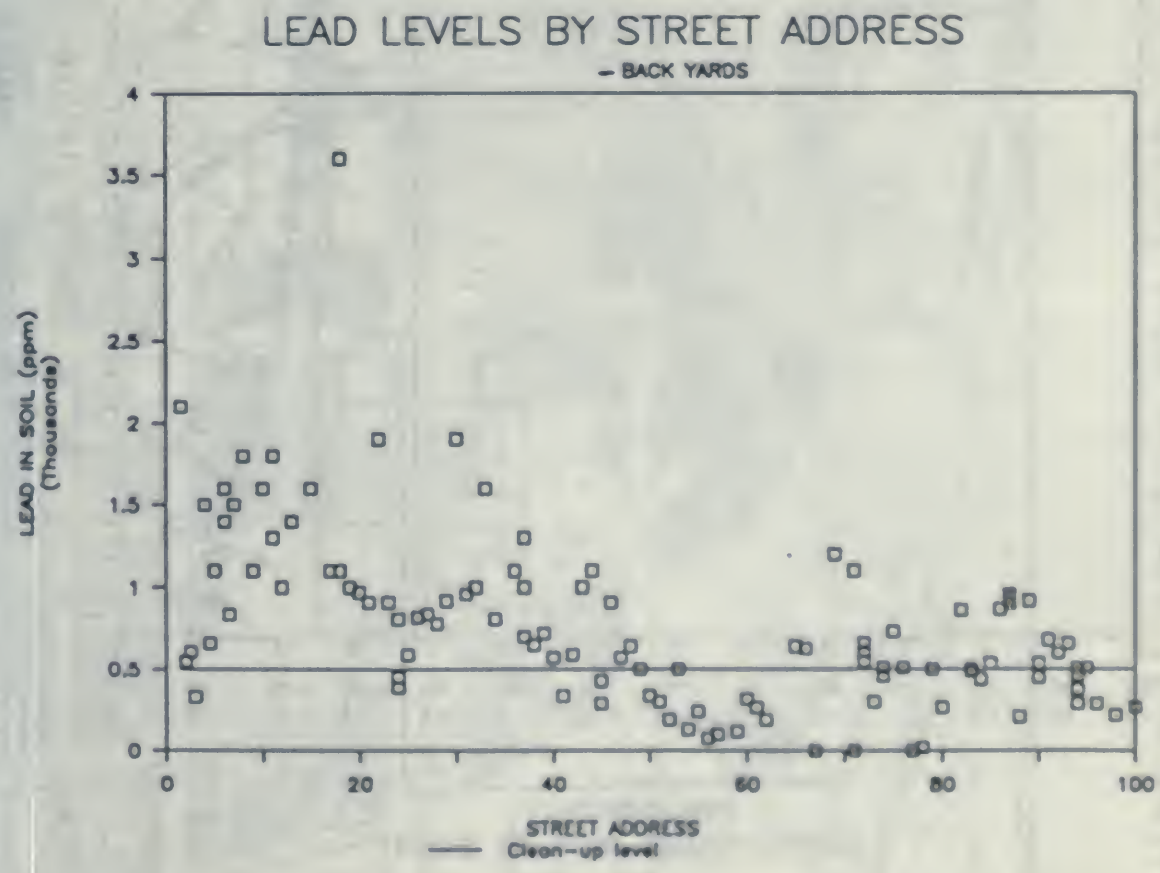
SOIL REPLACEMENT DECISION PROTOCOL



(courtesy SENES Consultants)

(Figure 3)





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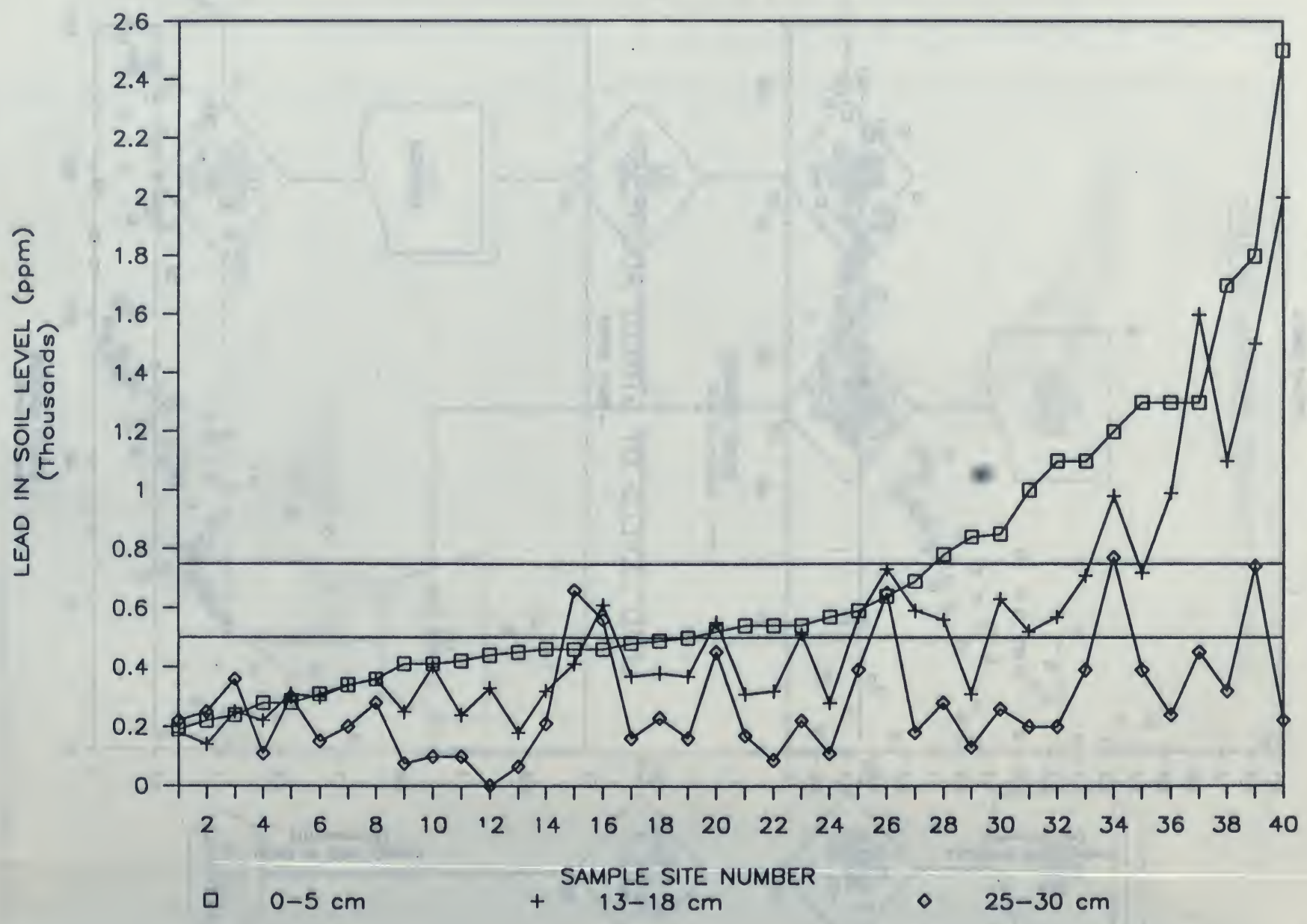
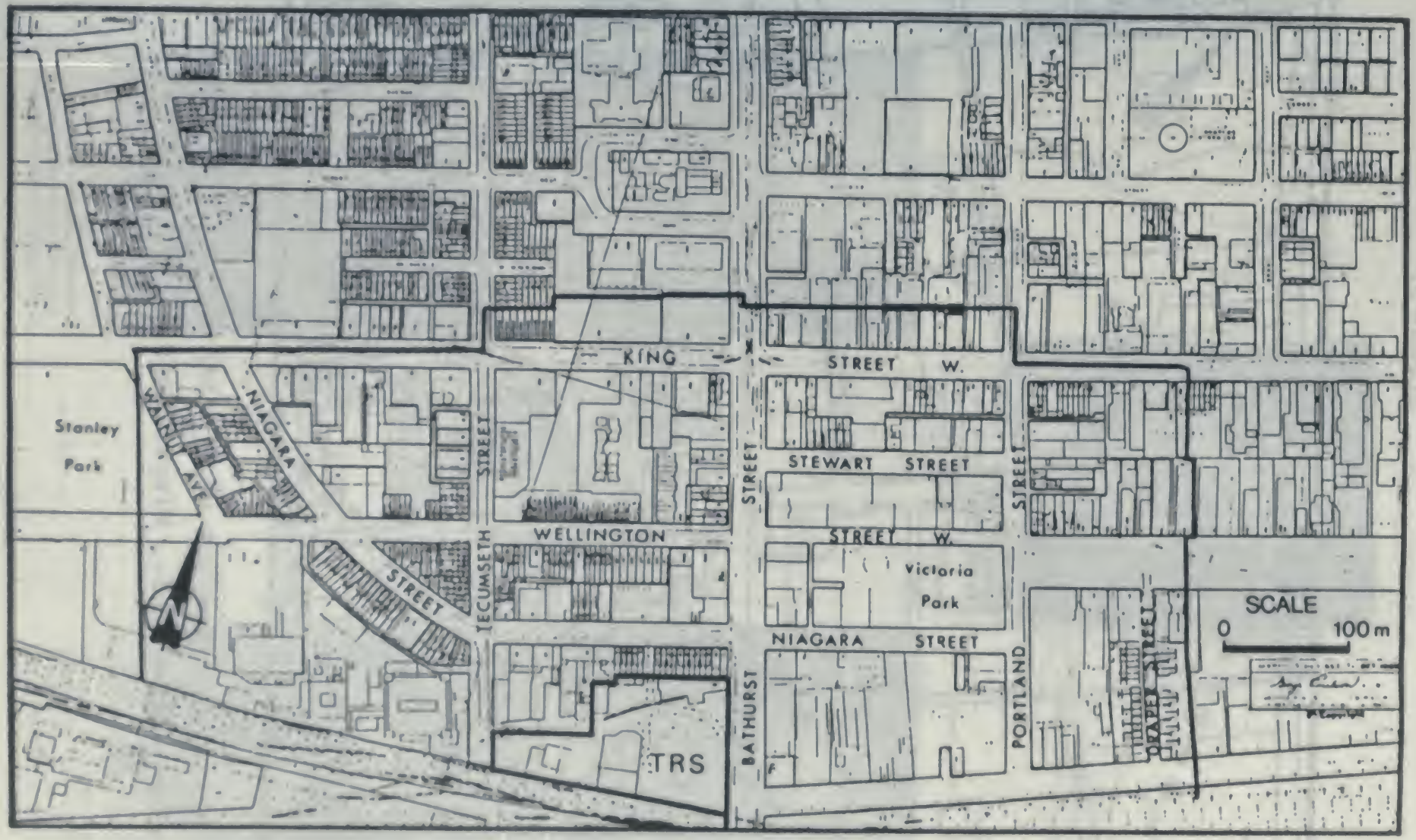


(Figure 4)

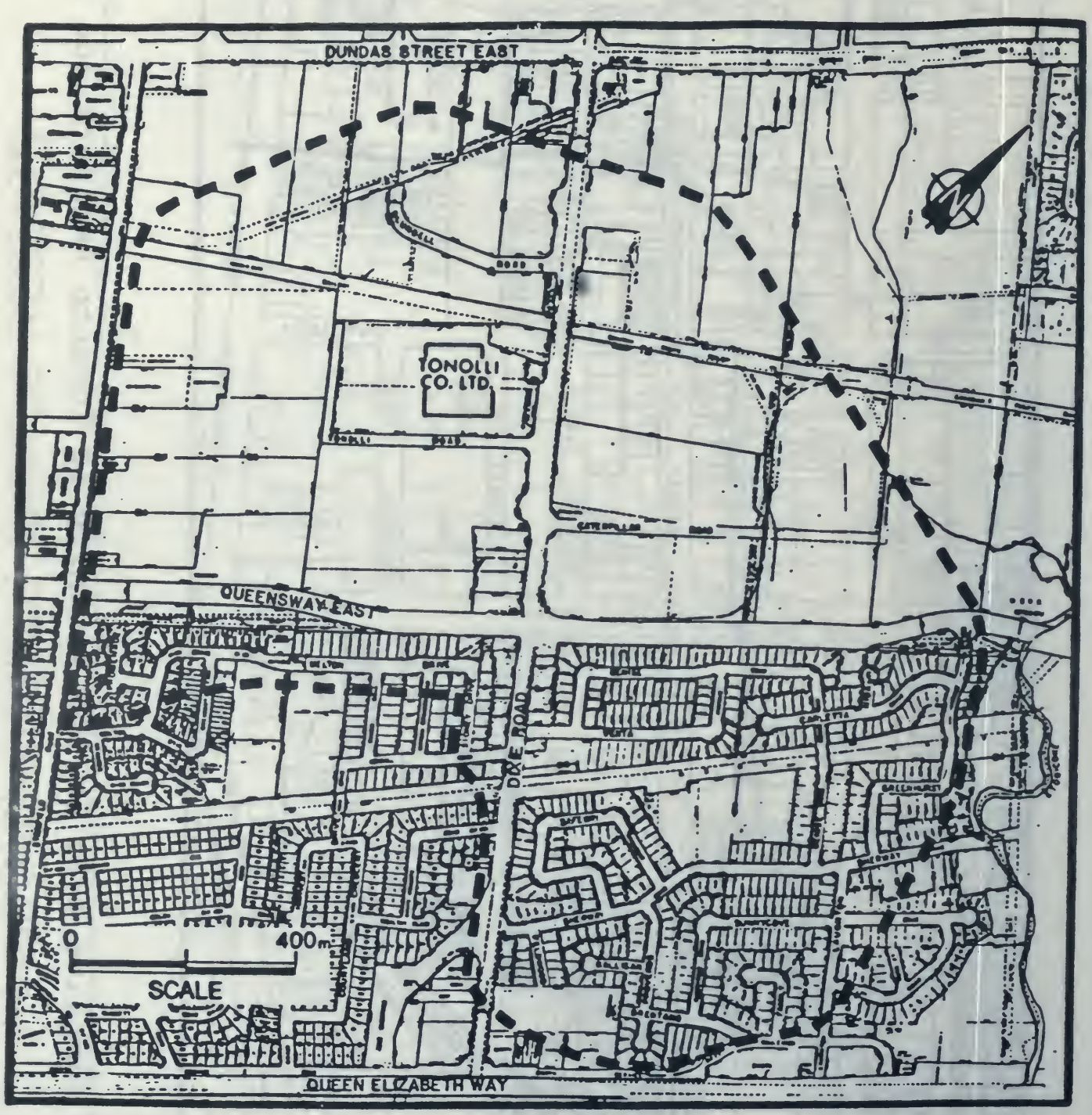
(courtesy SENES Consultants)



(Figure 5)

Designated soil sampling area in the vicinity of Toronto Refiners and Smelters

(Figure 6)



Area from which soil samples were taken in the vicinity of Tonolli Co. of Canada Ltd., Mississauga, 1987

Moderator: C.E. McIntyre, Executive Director, Approvals and Engineering Division, Environment Ontario, Toronto

N. Borodczak, Assistant Director, MISA Office, Water Resources Branch, Environment Ontario, Toronto

Dr. G.F. Westlake, Supervisor, Aquatic Toxicity Unit, Water Resources Branch, Environment Ontario, Toronto

J. Onderdonk, Manager, Agricultural & Industrial Chemicals Section, Hazardous Contaminants Branch, Environment Ontario, Toronto

Conrad H. Eidt, Director of Engineering, Regional Municipality of Niagara Public Works Department, Thorold, Ontario

M. I. S. A.

MUNICIPAL - INDUSTRIAL STRATEGY FOR ABATEMENT

ENVIRONMENT ONTARIO'S NEW PROGRAM FOR CUTTING TOXIC WASTES

by

N. Borodczak, Assistant Director, MISA Office,
Water Resources Branch, Environment Ontario,
Toronto

MISA was announced by

Ontario Environment Minister

Jim Bradley

in June, 1986

Its goal: the virtual elimination of toxic contaminants discharged into Ontario waters.

MONITORING REGULATION

- Requires dischargers to identify and measure concentrations and amounts of toxics in their effluent
- Specifies sampling, analytical and data reporting protocols
- Self-monitoring program to be audited by MOE

LIMITS REGULATION

- Specifies allowable concentrations, amounts of toxic pollutants for each discharger
- Specified levels to be based on BAT - Best Available Technology - economically achievable
- Limits to be developed for each sector

PROGRAM SEQUENCE

- Pre-Regulation cooperative monitoring
  - by industrial and municipal sectors
  - includes effluent characterization, variability and routine monitoring

leading to:

- MONITORING REGULATION
  - sampling and analytical protocols
  - reporting and disclosure

leading to:

- COMPLIANCE REGULATION
  - effluent limits
  - violation responses

leading to:

- CONTROL ORDERS FOR ABATEMENT
  - specific to each discharger
  - time schedule for compliance

9 Major Industrial Sectors

- Petroleum Refining
- Organic Chemicals
- Pulp & Paper
- Metal Mining & Refining
- Iron & Steel
- Industrial Minerals
- Inorganic Chemicals
- Electric Power Generation
- Metal Casting

Municipal Sector

- Sewage Treatment Plants

THE PUBLIC ROLE

- White Paper public review and comment
- MISA Advisory Committee reviews draft regulations and makes recommendations
- Formal period for public review of draft regulations
- Complete access to contaminants discharge data, compliance status and abatement progress

NATIONAL PERSPECTIVE

MISA IS STRONGLY SUPPORTED BY TECHNICAL/SCIENTIFIC RESOURCES OF ENVIRONMENT CANADA.

INVOLVEMENT BRINGS:

- a national perspective to MISA's implementation
- transfer of pollution control measures to the rest of Canada

TRANSFER OF MISA NATION-WIDE

IMPLICATIONS:

- First monitoring regulation (for Petroleum Refining Sector) has implications for refineries in other provinces

- Promulgating regulations for other sectors in Ontario will have implications for other provinces

TRANSFER OF MISA NATION-WIDE

ACTIONS:

- Environment Ontario is prepared to conduct workshops, briefings, etc. on MISA across Canada

- Environment Ontario would sponser a national workshop under auspices of CCREM

EFFLUENT MONITORING PRIORITY POLLUTANTS LIST (EMPPL)

Criteria based on:

1) **Environmental Behavior Parameters**

- **Environmental Transport**
- **Environmental Persistence**
- **Bioaccumulation**

EMPPL Criteria cont.

2) Toxicity Parameters

- Acute lethality
- Sub-lethal effects on non-mammalian animals
- Sub-lethal effects on plants
- Sub-lethal effects on mammals
- Teratogenicity
- Genotoxicity/Mutagenicity
- Carcinogenicity

SECTOR STATUS

Petroleum Refining (7 refineries):

- Draft monitoring regulation released July 1987
- MOE assessing public comments on draft
- Revision of draft reg. accordingly
- Joint industry/MOE efforts - training
  - implementation
- Monitoring reg. received government approval during week of June 6/88
- Monitoring reg. expected to be gazetted June 26/88

06/88

SECTOR STATUS

Organic Chemicals (19 plants):

- Final draft monitoring regulation to MOE management now
- Monitoring will be pipe specific (wide variation in plant sizes, processes and operations)
- Public release of draft reg. expected Fall 1988

07/88

SECTOR STATUS

<u>Mineral Industry</u>:
(Mining & Industrial Minerals)

- One JTC, 2 groups
  - Mining - 50+ active sites
    - 100's of abandoned sites
  - Minerals - 2,000 facilities

- Each group will work in terms of subsectors to reflect diversity of operations & effluents, e.g.,
  - industrial minerals: sand & gravel, limestone, gypsum, etc.
  - mining: gold, silver, nickel, copper, etc.

02/88

SECTOR STATUS

Mineral Industry (cont'd):

- Draft monitoring regulation being developed for each group
- Pre-regulation monitoring completed for both groups
- Public release of both draft monitorings regs. expected end of 1988

07/88

SECTOR STATUS

Pulp & Paper (27 mills):

- Pre-regulation monitoring completed
- Preparation of draft monitoring reg. underway
- Key provision: ongoing revision of monitoring parameters list
- Public release of draft reg. expected end of 1988

07/88

EXPERT COMMITTEE ON KRAFT MILL TOXICITY

- Set up in response to Kimberley-Clark control order of March 1987
- Members:
  - Dr. John Sprague - U. of Guelph (Toxicity)
  - Mr. Neil McCubbin - P. Eng. (Process)
  - Mr. Norman Bonsar - Lakehead U. Head, Economics (Economic)
- Tasks - Literature review
  - Site visits
  - discussions with other jurisdictions

02/88

EXPERT COMMITTEE ON KRAFT MILL TOXICITY

Terms of Reference:

- Identify treatment technology that could be applied to meet MISA toxicity & toxic removal objectives
- Identify wastewater components that could cause lethality or be persistently toxic
- Critically review MOE's static bioassay procedures
- Assess economic/market implications of each technical solution identified

EXPERT COMMITTEE ON KRAFT MILL TOXICITY

Operation:

- Proceed independently of both MOE & industry for objective reporting (but with MOE/industry cooperation)
- Review of draft report by both MOE & industry
- Final report released for public comment April 1988
- Comments being reviewed by MOE prior to developing final position
- Report will be input for determination of BAT(EA) for sector

06/88

SECTOR STATUS

Iron & Steel (7 facilities):

- Pre-regulation monitoring begun Jan. 1988
- Three monitoring schedules being developed: integrated, specialty and scrap remelting operations
- Industry to identify members to work with reg. writing team - first meeting held June 8, 1988
- Public release of draft monitoring reg. expected by mid1989

07/88

SECTOR STATUS

Electrical Power Generation:
(6 thermal, 3 nuclear, 68 hydroelectric)

- Ontario Hydro completed pre-regulation monitoring on most thermal & nuclear plants
- MOE reviewed data, requested additional monitoring
- Final report expected by July, 1988
- Discussions underway between MOE & AECB to determine monitoring responsibilities
- Public release of draft monitoring reg. expected mid 1989

07/88

SECTOR STATUS

Inorganic Chemicals (21 facilities):

- Several JTC meetings held; site visits completed
- Pre-regulation monitoring begun Jan. 1988
- Range of plant sizes, processes & operations (may require site or pipe-specific monitoring schedules)
- Public release of draft monitoring reg. expected mid 1989

07/88

SECTOR STATUS

Metal Casting (50 plants):

- New sector
- Pre-regulation monitoring begun early 1988
- P. expected mid 1989

07/88

SECTOR STATUS

Municipal (400 STPs):

- 2 elements under development:
  - effluent regulations for STPs
  - sewer-use control program
- 2 separate JTCs responsible for these elements
- JTC for STP reg. meeting since summer 1986
- 40-STP survey of toxics in influents, effluents & sludges completed; report finalized Aug. 1988
- STP draft monitoring reg. being developed

07/88

TOXIC ORGANICS - NEW CHALLENGE

- **Even at low concentrations, can have serious effects on all life forms**
- **Some are persistent**
  - **degrade slowly**
  - **accumulate in biota & ambient environment**
- **Some present in STP effluents**
- **STP treatment can remove some toxics; others can pass through treatment**

TREATMENT OF TOXICS

Problems with STP treatment:

- Toxics transferred to other media (to air - sludge incineration; to soil - sludge application on agricultural land)
- Volatile organics escape to air during treatment
- Costly STP treatment technology

02/88

SEWER USE

Past

- Municipal STPs main safeguard against sewage pollution
- STPs designed to treat sanitary sewage
- Waste volume & complexity has increased

Now

- At least 12,000 industries discharge broad range of contaminants into sewers
- Some wastewater discharges contain toxic contaminants

02/88

TREATMENT OPTIONS

- Advanced STP treatment
  - costly
  - likely joint industry/municipal costs & operation

- Control at source
  - specialized control & containment measures at industrial waste site
  - discharger bears costs & responsibility

02/88

SEWER USE CONTROL

- **Ontario developing sewer-use control program which will:**
  - **complement MISA regulations for direct dischargers**
  - **address challenge of toxics for effective sewage treatment**

02/88

STAGED DEVELOPMENT

1) 2-Phase consultant study

- Phase I
  - review 16 control programs (Canada, U.S., Europe)
  - screen for compatibility to Ontario/MISA
  - 4 options selected
  - released Nov. 1987

- Phase II
  - evaluate 4 selected options plus next best 4 options
  - cost & effectiveness criteria
  - select preferred option
  - release: Feb. 1988

02/88

STAGED DEVELOPMENT

2) MOE discussion paper (based on information in related studies to date

- Content
  - MOE's preferred option
  - development process
  - enforcement methods
  - roles of dischargers/governments
  - financing options

- Release: June/July 1988

- Public review & comment

06/88

STAGED DEVELOPMENT

3) Evaluation

- Public comments considered
- Economic impacts assessed
- Sewer-use control program finalized

4) Development & implementation

- Considerations:
  - infrastructure
  - legal mechanisms
  - financing

02/88

IMPLEMENTATION MECHANISMS

Preliminary Suggestions:
(dependent on final program selection)

- **Province-wide regulation requiring industrial sewer dischargers to comply with specified limits**

- **Regulation requiring municipalities to enforce a uniform sewer-use bylaw**

INTERIM STRATEGY

- Model sewer-use bylaw currently used by some municipalities to develop own local bylaw

- Model bylaw recently revised & strengthened (general toxics provision); release Summer 1988

- MOE provides assistance/guidance to municipalities re:

  - interpretation of bylaw
  - inspection
  - sampling procedures
  - lab procedures
  - training
  - enforcement mechanisms

06/88

BIOLOGICAL ASSESSMENT FOR WATER POLLUTION CONTROL

by

Gary F. Westlake and John G. Ralston

Aquatic Biology Section

Water Resources Branch

Ontario Ministry of the Environment

Rexdale, Ontario

1 ABSTRACT

A review of the past ten years' aquatic toxicity data on industrial effluent samples, reveals that many discharges in the province are still acutely lethal to aquatic animals. Strategies for obtaining improvement in water quality must involve goals that can be achieved for at least the majority of effluents. Present quality has yet to improve to the point in Ontario where acute lethality tests on whole effluents cease to be the most effective monitoring tools. Biological monitoring procedures in the laboratory and in the field are the most effective and cost-efficient tools for water quality monitoring and control. Chemical characterization of effluents depends, for interpretation, on a frequently non-existent or inadequate toxicity literature. Whole effluent toxicity testing provides the logical solution. Separate control of water use per unit of production, lethal and sublethal impacts of effluents, and persistent bioaccumulating and chronically acting toxic substances needs to be achieved. Simple acute lethality tests using more than one trophic level are the most powerful ways to improve discharge quality.

2 INTRODUCTION

Toxicity testing is a basic component of new monitoring regulations currently being developed in Ontario as part of the MISA (Municipal Industrial Strategy for Abatement) program (MOE, 1986). While it is premature to estimate the extent biologically based limits will be incorporated into subsequent compliance regulations, it is logical to expect that they will be important. It would be illogical to try to eliminate toxic substances from industrial and municipal effluents without assessing the whole effluent for toxic effects.

3 EQUITABLE WATER POLLUTION CONTROL

In order to accomplish this regulatory initiative, the Ministry needs to establish biological as well as chemical limits on sources. On the biological side, an environmentally relevant measure of quality is required that is realistic for the available treatment technology of a broad spectrum of discharge types. The role of the public servant in administering these requirements needs to be carefully examined. Formal policies need to be set and faithfully followed if the require-

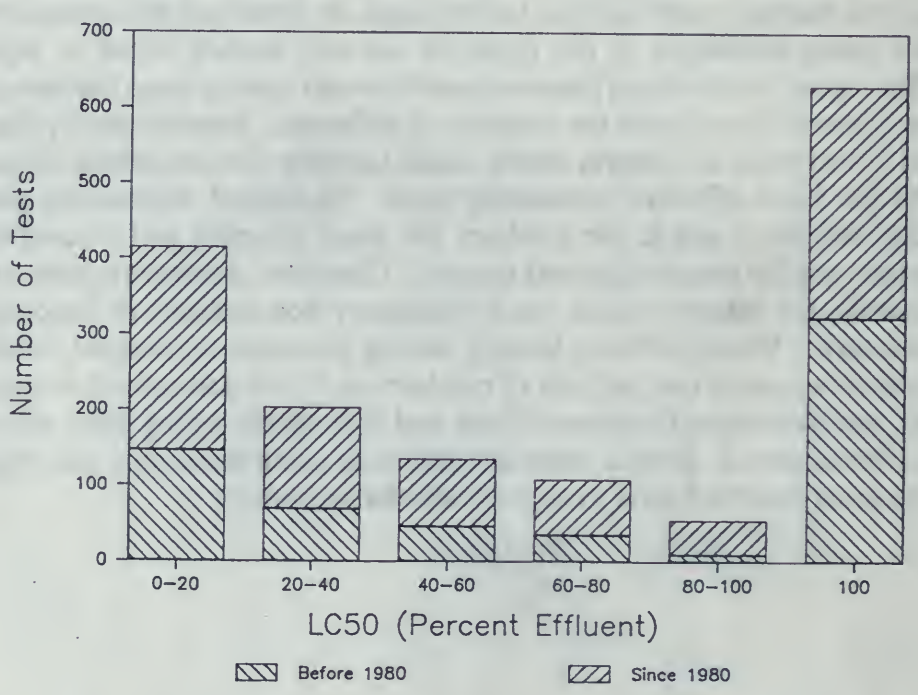


Figure 1. *Acute lethality of effluent samples to rainbow trout.*

ments are to be uniformly applied. Priorities need to maximize benefits to receiving environments without picking on individual industries or the easiest to prosecute.

3.1 Setting Goals that Can be Achieved for all Sources

The Ontario Ministry of the Environment aquatic toxicity laboratory in Rexdale

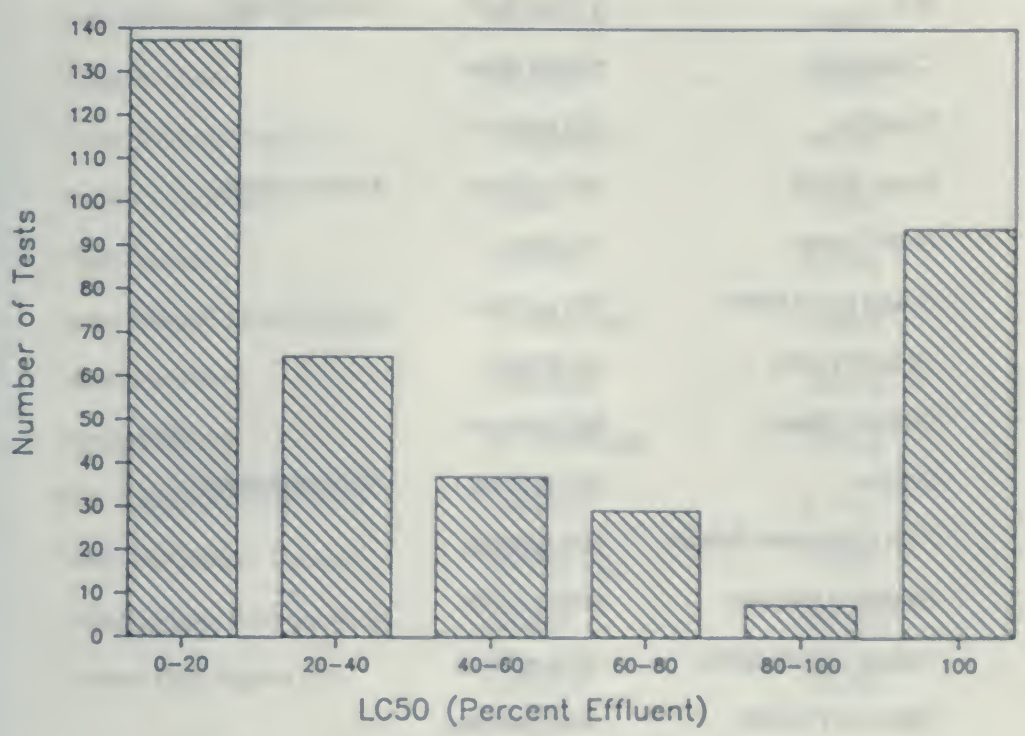


Figure 2. *Acute lethality of pulp and paper effluents to rainbow trout.*

has a long history of monitoring industrial discharges for acute lethality to fish. Within the past three years monitoring for acute lethality to *Daphnia magna* has been routinely added. From this body of information, an overview can be obtained on the quality of effluents in the province. Figure 1 shows some acute lethality data from effluent samples for trout over the past ten years. These toxicity tests were performed by or for the Ministry using the static protocol. While the data is biased because sources were sampled irregularly for a variety of

Table 1. **Recent court cases involving the Aquatic Biology Section.**

Case	Aproximate Volume Alleged to be Spilled	Notes
BCL	5 Tons Acid	3 occurrences
Courtaulds	40,000 litres	
Donalco	300 gallons	
Esso, Sarnia	100 gallons	4 occurrences
Golf Course	15 gallons	
Green Lawn Farm	200 gallons	
Ontario Hydro	5023 liters	
Ontario Paper	500 gallons	
Polysar	300 gallons	16 occurrences
Port Colbourne Poultry	200 gallons	
Siegfried Kriesner	1000 gallons	
Vespera Municipality	1000 gallons	
Windsor Bumper	1000 gallons	

purposes, it clearly shows that there are a significant number of effluents in Ontario that kill fish. Figure 2 isolates the pulp and paper data from this total and shows a similar pattern except that there were proportionally more toxic samples. It should be pointed out that samples were not chosen for the purposes of this evaluation but to serve the requests of regional and other programs. Even though the sampling was not evenly distributed, the results indicate, in Ontario, that we have some distance to go before sublethal procedures will have a significant advantage for monitoring and control purposes.

Table 2. **Flows of effluents greater than 100,000 Cu M/Day tested by the Ministry's aquatic tocicity laboratory. (Source - MOE, 1987).**

Industry	Location	Annual Average Flow Cu M/Day
Stelco	Hamilton	1056689
Dow Chemical of Canada	Sarnia	762710
eldorado Nuclear Ltd.	Port Hope	746665
Dofasco Steel	Hamilton	655000
Canadian Industries Ltd.	Courtwright	270699
Polysar Corporation	Sarnia	258625
Shell Canada	Corunna	222885
Great Lakes Forest Products	Thunder Bay	215833
Noranda-Hemlo	Marathon	131873
General Motors	St. Catherines	129168
E.B. Eddy Forest Products	Espanola	112417
Kimberly-Clark of Canada	Terrace Bay	110333
Ontario Paper Company Ltd.	Thorold	107200
Domtar Fine Papers Ltd.	Cornwall	100750

In the light of this current state of discharge quality, it is unrealistic to try to remove all sublethal effects at the point of release of industrial wastes. It may, however, be possible to remove acute lethal effects for all sources in the province. It may also be possible to eliminate widespread sublethal and chronic effects through restricting them to a small initial mixing area downstream of discharges. As will be discussed later, most measurable sublethal effects are observed at concentrations relatively close to those causing lethality. Therefore, except for receiving environments with limited flows, controlling acute lethality will also

control most, if not all, sublethal impacts, with the exception of the bioaccumulation of persistent toxic substances.

3.2 Do the Same Standards Apply to Continuous Discharges as to Accidental Spills?

It is easy to concentrate pollution control efforts on the small pollution sources because these are easier to study and to prosecute. If the criteria for success is the number of successful court cases, then this is an effective strategy. However, if the criteria is the extent of environmental improvement, then concentrating on the small and accidental discharger is ineffective. Table 1 shows court cases that the Aquatic Biology Section has been involved with, along with what was alleged to be discharged. Compare this with Table 2 showing, in decreasing order of volume discharged, effluents that have been tested for toxicity by the Ministry. The largest of these flows could fill three supertankers every day. Many of these major volumes, some of them toxic, are legally being discharged to the receiving environment through the control order process. More improvement in water quality can be obtained from improving the quality of these than those of accidental spills which may happen no matter how many precautions are taken.

4 THE POWER OF BIOLOGICAL MONITORING

Biological tests are powerful instruments for pollution monitoring and control. They measure potential, environmentally significant effects of complex mixtures directly.

They are also cost effective, rapid and simple to perform. Considering them only as a group of analyses among the many that can be used to characterize an effluent is absurd. Their role is indispensable. Not only are biological tests used to assess effluent quality directly, but also indirectly through surface water quality objectives and guidelines.

4.1 Biological vs. Chemical Monitoring

Most industrial effluents are complex mixtures of substances even in cases where one or two substances predominate. The Ministry of the Environment has prepared a list of substances for characterizing industrial effluents. This list,

Table 3. Substances identified by Ontario's Effluent Monitoring Priority Pollutants List as Occuring in Major industries in the Province. (Source - MOE, in press).

Pulp and Paper Mills

1,1,2,2-Tetrachloroethane	Anthracene	Chrysene	Mercury	Stryrene
1,1,3,3-Tetrachloroacetone	Arsenic	cis-1,3-Dichloroporopylene	Methyl ethyl ketone	Tetrachloroethylene
1,1,3-Trichloroacetone	Benz (a) anthracene	Cobalt	Methylene chloride	Tetraethyl lead
1,2,3,4-Tetrachlorobenzene	Benzaldehyde	Copper	Molybdenum	Thiourea
1,4-Dichlorobenzene	Benzene	Cyanide	m-Cresol	Toluene
1-Methylnaphthalene	Benzo (a) pyrene	Dehydroabietic acid	m-Xylene	trans-1,3-Dichloropropylene
2,3,4,6-Tetrachlorophenol	benzo (b) fluranthene	Di-n-butylphthalate	Naphthalene	Tributyl phosphate
2,3,4-Trichlorophenol	Benzo (g,h,i) perylene	Eugenol	Neoabietic acid	Trichloroethylene
2,3,5,6-Tetrachlorophenol	Benzo (k) fluoranthene	Fluoranthene	Nickle	Trichloroguaiacol
2,4,5-Trichlorophenol	Benzyl alcohol	Fluorene	n-Methylformamide	Zinc
2,4,6-Trichlorophenol	bis(2-ethylhexyl)phthalate	Hexachlorobenzene	n-Nitrosodi-n-propylamine	
2,4-Dichlorophenol	Butanal	Hexachlorocyclopentadiene	Octachlorostyrene	
2,4-Dimenthylphenol	Cadmium	Hydrazine	o-Cresol	
2,6-Di-t-butyl-4-menthylphenol	Camphene	Hydroxycyclohexane	o-Xylene	
2-Methylnaphthalene	Carbon tetrachloride	Indeno(1,2,3-cd)pyrene	Pentachlorobenzene	
4-Chloro-3-methylpenol	Chlorinated dibenzofurans	Isopimaric acid	Phenol	
4-Nitrophenol	Chlorodehydroabietic acid	Lead	Pimaric acid	
Abietic Acid	Chlorodibromomethane	Levopimaric acid	Pryene	
Acenaphthene	Chloroform	Limonene	p-Cresol	
Acenaphthylene	Chromium	Mercaptobenzothiazole	p-Xylene	
Aluminum				

Oil Refineries

1,1-Dichloroethene	Arsenic	Ethylene dibromide	p-Xylene
1,2,3,4-Tetrachlorobenzene	Benz (a) anthracene	Fluoranthene	Selenium
1,2,4-Trichlorobenzene	Benzene	Fluorene	Tetrachloroethylene
1,2-Dichlorobenzene	Benzidine	Hexachlorobenzene	Thallium
1,2-Dichloroethane	Benzo (a) pyrene	Hexachlorobutadiene	Toluene

Table 3. **(continued).**

1,2-Dichloropropane	benzo (b) fluranthene	Hexchloroethane	trans-1,2-Dichloroethylene
1,3-Dichlorobenzene	Benzo (g,h,i) perylene	Hydrazine	Trichloroethylene
1,4-Dichlorobenzene	Benzo (k) fluoranthene	Indeno(1,2,3-cd)pyrene	Trichlorofluromethane
2,3,4,5-Tetrachlorophenol	Benzyl alcohol	Lead	Vanadium
2,3,4,6-Tetrachlorophenol	Beryllium	Mercury	Vinyl chloride
2,4-Dichlorophenol	bis(2-ethylhexyl)phthalate	Molybdenum	Zinc
2,4-Dimenthylphenol	Cadmium	m-Xylene	
4,6-Dinitro-o-cresol	Carbon tetrachloride	Naphthalene	
4-Bromphenyl phenyl ether	Chloroform	Nickle	
4-Nitrophenol	Chromium	Octachlorostyrene	
Acenaphthene, 5-nitro	Chrysene	o-Xylene	
Acenaphthylene	Cobalt	Pentachlorobenzene	
Alumiunm	Copper	Pentachlorophenol	
Anthracene	Dibenzo (a,h) anthracene	Pimaric acid	
Antimony	Di-n-butylphthalate	Pryene	

Municipalities

1,1,2-Trichloroethane	2-chloroisopropoyl	Aroclor 1016	Bromomethane	Hexachlorobenzene
1,1-Dichloroethane	2-Chloronaphthalene	Aroclor 1221	Butylbenzylphthalate	Hexachlorobutadiene
1,1-Dichloroethylene	2-Chlorophenol	Aroclor 1232	Cadmium	Hexachlorocyclopentadiene
1,2,3,4-Tetrachlorobenzene	2-Hydroxybiphenyl	Aroclor 1242	Carbon tetrachloride	Hexchloroethane
1,2,4-Trichlorobenzene	2-Methylnaphthalene	Aroclor 1248	Chlorinated dibenzofura	Indeno(1,2,3-cd)pyrene
1,2-Dichlorobenzene	3,3-Dichlorobenzidine	Aroclor 1254	Chlorobenzene	Indole
1,2-Dichloroethane	4-Bromphenyl phenyl ether	Aroclor 1260	Chlorodibromomethane	Lead
1,2-Dichloropropane	4-Chlorophenylphenyl ether	Benz (a) anthracene	Chloroform	Mercaptobenzothiazole
1,3-Dichlorobenzene	4-Chloro-3-methylpenol	Benzaldehyde	Chloromethyl	Mercury
1,4-Dichlorobenzene	4-Hydroxybiphenyl	Benzene	Chromium	Methylene chloride
1,4-Dioxane	4-Nitrophenol	Benzidine	Chrysene	Molybdenum
1-Methylnaphthalene	Abietic Acid	Benzo (a) pyrene	Copper	m-Xylene
2,3,4,5-Tetrachlorophenol	Acenaphthene	benzo (b) fluranthene	Cyanide	Naphthalene
2,3,4,6-Tetrachlorophenol	Acenaphthylene	Benzo (g,h,i) perylene	Dibenzo (a,h) anthracen	Nickle
2,3,5,6-Tetrachlorophenol	Acrolein	Benzo (k) fluoranthene	Dimethyl disulphide	n-Nitrosodimethylamine
2,4-Dichlorophenol	Acrylonitrile	Benzyl alcohol	Diphenyl ether	n-Nitrosodiphenylamine
2,4-Dimenthylphenol	Alumiunm	Beryllium	Di-n-butylphthalate	n-Nitrosodi-n-propylamine
2,4-Dinitrophenol	Aniline	Biphenyl	Ethylene dibromide	Octachlorostyrene
2,4-Dinitrotoluene	Anthracene	bis(2-ethylhexyl)phthalate	Fluoranthene	o-Xylene
2,6-Dinitrotolene	Antimony	Bromoform	Fluorene	Pentachlorobenzene

Table 3. (continued).

Organic Chemical Industries

1,1,2,2-Tetrachloroethane	2,3,7,8-Tetrachlorodibenzo	Acrylonitrile	Dibenzo (a,h) anthracene	Pentachlorobenzene
1,1,2-Trichloroethane	2,4,5-Trichlorophenol	Aiumiunm	Diphenylamine	Pentachlorophenol
1,1,3-Trichloroacetone	2,4,5-Trichlorotoluene	Aniline	Di-n-butylphthalate	Phenol
1,1-Dichloroethane	2,4,6-Trichlorophenol	Anthracene	Ethylene dibromide	Pryene
1,1-Dichloroethylene	2,4-Dichlorophenol	Benz (a) anthracene	Eugenol	Tetrachloroguaiacol
1,2,3,5-Tetrachlorobenzene	2,4-Dinitrophenol	Benzene	Fluoranthene	Thallium
1,2,3-Trichlorobenzene	2,4-Dinitrotoluene	Benzo (a) pyrene	Fluorene	Thiourea
1,2,4-Trichlorobenzene	2,6-Dichlorophenol	Benzo (g,h,i) perylene	Formaldehyde	Toluene
1,2-Dichlorobenzene	2,6-Dinitrotolene	Benzo (k) fluoranthene	Hexachlorobenzene	trans-1,3-Dichloropropylene
1,2-Dichloroethane	2,6-Di-t-butyl-4-menthylphenol	Benzyl alcohol	Hexchloroethane	Triethyl lead
1,2-Dichloropropane	2-chloroethoxy	Bromoform	Hydrazine	Trimethylbenzenes
1,3-Dichlorobenzene	2-chloroisopropoyl	Cadmium	Indeno(1,2,3-cd)pyrene	Trimethylnapthalene
1,4-Dichlorobenzene	2-Methylnaphthalene	Carbon tetrachloride	Isopimaric acid	Zinc
1,4-Dioxane	2-Nitronaphthalene	Chlorobenzene	Levopimaric acid	
1-Methylnaphthalene	3,3-Dichlorobenzidine	Chlorodibromomethane	Mercaptobenzothiazole	
1-Nitronaphthalene	4-Aniozobenzene	Chloroform	Mercury	
2,3,4,5-Tetrachlorophenol	Acenaphthene	Chromium	Methyl styrene	
2,3,4,6-Tetrachlorophenol	Acenaphthene, 5-nitro	Chrysene	Naphthalene	
2,3,5,6-Tetrachlorophenol	Acenaphthylene	Cobalt	Nickle	
2,3,5-Trichlorophenol	Acrolein	Copper	Octachlorostyrene	

Inorganic Chemical Industries

1,4-Dioxane
1-Methylnaphthalene
2,6-Dinitrotolene
2-Methylnaphthalene
Hydrazine

Iron and Steel Industry

1,1,2,2-Tetrachloroethane	Benzo (a) pyrene	m-Xylene

Table 3. (continued).

1,1,3,3-Tetrachloroacetone
1,1,3-Trichloroacetone
1,1-Dichloroethane
1,1-Dichloroethylene
1,2,3,5-Tetrachlorobenzene
1,3-Butadiene
1,4-Dichlorobenzene
1,4-Dioxane
2,4-Dimenthylphenol
2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Acridine
Anthracene
Arsenic
Benz (a) anthracene
Benzene
Benzeneacetonitrile
Benzidine
benzo (b) fluranthene
Benzo (g,h,i) perylene
Benzo (k) fluoranthene
Cadmium
Chlorodibromomethane
Chloroform
Chloromethyl
Chrysene
Copper
Cyanide
Dibenzo (a,h) anthracene
Di-n-butylphthalate
Fluoranthene
Fluorene
Hydrazine
Indeno(1,2,3-cd)pyrene
Indole
Lead
m-Cresol
Naphthalene
Nickle
o-Cresol
o-Xylene
Pryene
p-Cresol
p-Xylene
Selenium
Silver
trans-1,2-Dichloroethylene
Tributyl phosphate
Trichloroethylene
Trimethylnapthalene
Zinc

Power Generating Plants

1,1,2,2-Tetrachloroethane
3,3-Dichlorobenzidine
Chromium
Hydrazine
Thiourea

Industrial Minerals Industry

Hydrazine

Mining and Refining Industries

1,1,2,2-Tetrachloroethane
3,3-Dichlorobenzidine
Benzidine
Benzyl alcohol
Hydrazine
Thiourea
trans-1,2-Dichloroethylene

called the Effluent Monitoring Priority Pollutants List, is derived partly from documented occurrences of various substances in industrial and municipal effluents. Table 3 shows those substances identified in the list for each of the major industrial groups. It can be clearly seen that, even though not all members of an industrial group will necessarily contain all substances from that group, the list is formidable. Clearly, since this list is restricted to those substances that now can be measured by available technology, and is restricted to those that have so far been looked for, it is grossly incomplete.

While it is essential that effluents be characterized on the basis of at least some key chemical substances, the task of interpretation should not be underestimated. The potential environmental impact of these substances is evaluated by reference to toxicological literature. For some substances, the literature is scanty and for others, it is extensive. For very few substances, do we have information on combined effects of mixtures. Interpreting the results of analyses from concentrations of sometimes hundreds of substances in a given sample may require super-human capabilities.

The cost of doing the analyses is another factor to consider. Two people can realistically perform about 250 static trout tests or up to 500 *Daphnia* tests per year. The cost of trout tests generally range between $300 and $600 and *Daphnia* tests between $200 and $400. Chemical analyses can cost considerably more. The protocols insist that biological tests are completed within five days. Commonly, chemical characterization takes longer. Clearly biological testing of effluents has a place in testing strategies and often offers distinct advantages.

4.2 Water Quality Objectives, Guidelines, Criteria etc.

In characterising effluents chemically, it is often assumed that there exists enough knowledge about the effects of individual substances to make useful interpretations of the data. The Ministry is in the process of accelerating the development of Provincial Water Quality Objectives and Guidelines to support the MISA program. Many of the substances on the Effluent Monitoring Priority Pollutant List do not yet have enough toxicological data in the literature to develop Objectives. This is not surprising because few laboratories have the necessary sophisticated chemical analysis capabilities and because journals have become less interested in toxicity studies on yet another substance. It may be necessary for the Ministry to perform toxicity tests on a number of substances "in-house" or through contract in order to develop PWQOs.

In the complexity and difficulty of managing large amounts of chemical monitoring data, it is easy to forget that in order for the data to be interpreted environmentally, it is essential to have adequate toxicological literature. In light of the inadequate literature, this may be optimistic. The toxicity information for many substances is too scarce to make water quality management decisions solely on the basis of chemical characterization of whole effluents. It is possible, however, to monitor for biological effects on whole effluents and use the chemical characterization to interpret these effects. It is common for aquatic toxicity testing laboratories to review chemical data on a sample and suggest in their reports, potential causes for observed toxicity based on their knowledge of the literature.

5 TOXICITY AND WATER USE

It is a common view that requirements for toxicity reduction in effluents is in conflict with requirements for water conservation. Even in Canada where water is in abundance, we should be able to expect both. If we deal in "water use credits" for effluents of hundreds of thousand of cubic meters a day, how can we, in conscience, control small spills simply because they do not have the protection of a control order. The exception to this is for substances that bioaccumulate where loading estimates are useful.

5.1 Bioaccumulation

It is very difficult to simulate, in the laboratory, environmental conditions that permit a persistent substance to bioaccumulate in aquatic organisms. Neither acute lethal tests nor other readily available procedures do much to assess the potential for bioaccumulation from effluents. Similarly, although perhaps less obvious, is the fact that effect levels are frequently unknown because the literature on the mechanisms of bioaccumulation are limited and contradictory. There is a great need for controlled laboratory experimentation involving the uptake of substances into aquatic organisms.

The best information on the bioaccumulation of substances is from field monitoring of tissue concentrations and controlled field exposures involving caged organisms. The Ministry is involved with a number of programs for evaluating bioaccumulation in the field. Tissue analyses from sport fish over the past number of years have shown levels of contamination in the province and long term trends. Similarly, tissue levels in forage fish have helped to identify potential sources. Exposing aquatic organisms in cages to effluents in the field has also been used by the Ministry to assess the impacts of point sources.

For control of bioaccumulating substances, it is necessary to monitor and control the loading levels from point sources. It is not necessarily possible to directly measure the fate of substances through the ecosystem. Hydrophobic substances,

for example, are so readily accumulated by tissues that aquatic organisms can become contaminated even where the water column concentration is so low that it cannot be measured. It is possible to have bioaccumulation via water column concentrations that are below detection limits just as it is possible to fill a supertanker with a garden hose.

It is very difficult to predict the environmental fate and effects of substances that bioaccumulate. Scientists spend entire careers studying specific aspects of one compound or group of compounds. It is necessary to be conservative about the choice of substances we handle in this way because it represents major effort and it delivers returns slowly.

5.2 Acute and Chronic Effects

No one can deny the value of limiting water use through in-plant housekeeping etc. As a fundamental principle of water pollution control, minimizing volumes that become contaminated in the first place makes good sense. However, acute effects, both lethal and sublethal are concentration-based. It does not make sense to manage these impacts through controls on loading. Three things need to be controlled, and they can be controlled separately. First, limit water use per unit of production. Secondly, control lethal and sublethal acute impacts by end-of-pipe and edge-of-mixing zone limits. Thirdly, control the most persistent bioaccumulating and chronically acting substances through chemically monitoring and loading based limits, making sure to verify improvements with field monitoring.

6 PRACTICAL CONSIDERATIONS

The use of procedures from the toxicological literature for regulation has to be balanced against practical considerations of resource availability and relevance to present water quality. It is often the simplest of techniques that is most effective as long as the most possible benefit is obtained from the information that we do require.

6.1 THE POWER OF KEEPING IT SIMPLE

6.1.1 Being Aware of Existing Discharge Quality

If the present quality of discharges in the province was such that samples from them did not kill fish, then biological testing would have to involve more sensitive tests to get usable results. However this is currently not the case, as has been clearly demonstrated. It is attractive to the aquatic toxicologists to move on to

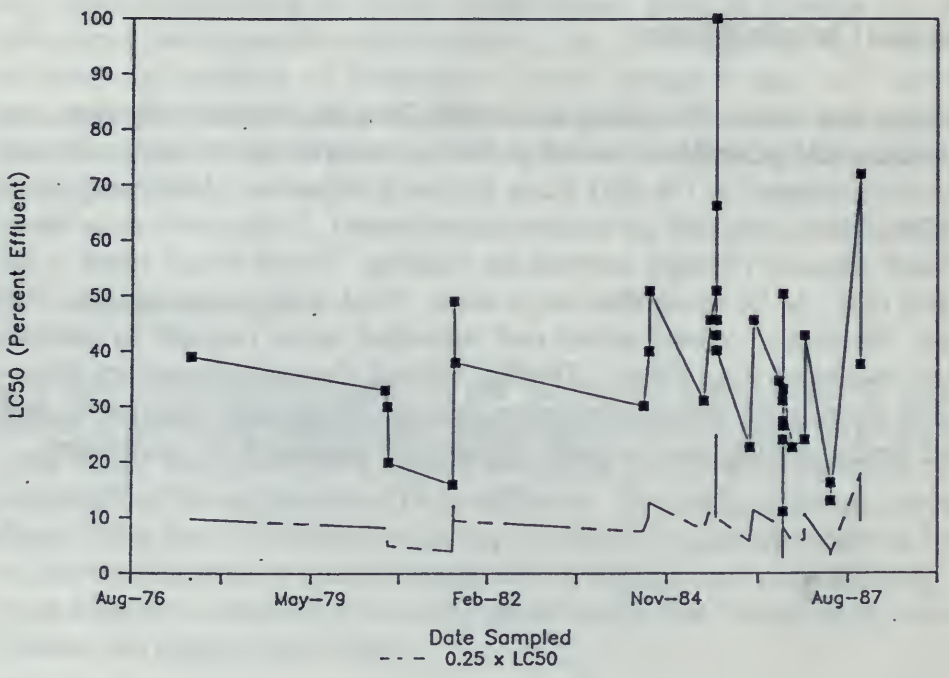


Figure 3. *Variability of an Industrial Effluent.*

procedures that are new because it makes our careers more interesting, but doing so would not be efficient for improving the environment resulting from the situations encountered today.

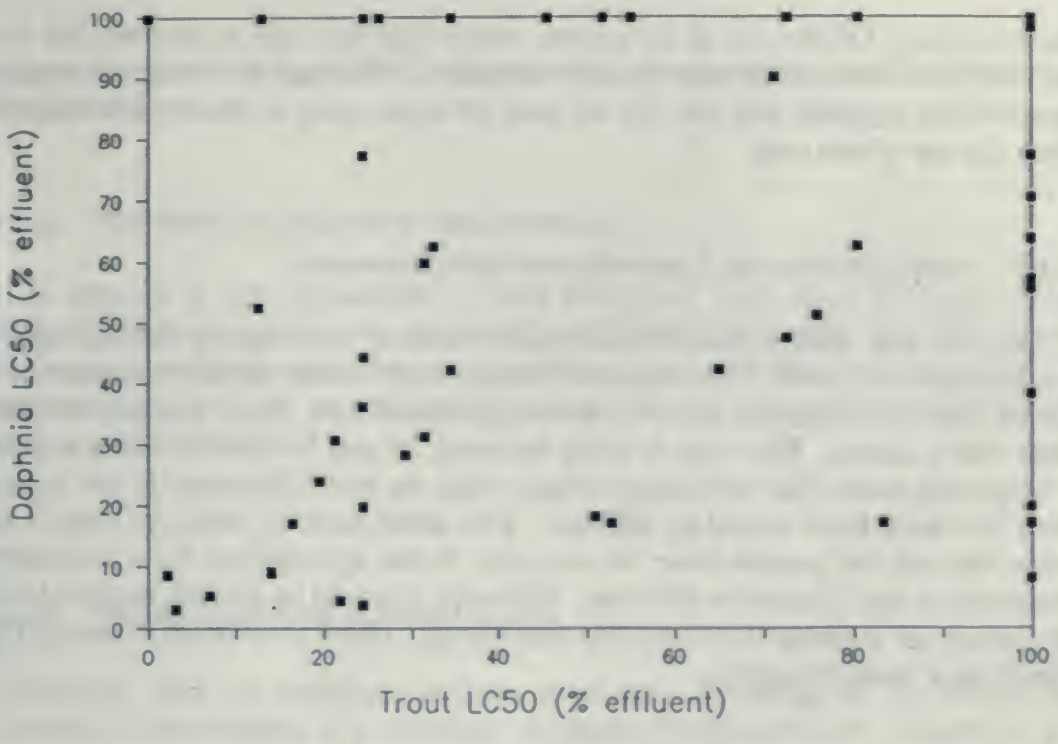


Figure 4. *Comparison of Trout and Daphnia magna Toxicity on the Same Effluent Samples.*

6.1.2

Appropriate Tests for Specific Needs

Figure 3 includes a plot of Acute Lethality LC50 Values for one of the dischargers in Ontario, collected over a number of years. It can be seen that the results are highly variable in time. A seven day growth test using Fathead minnows on the same discharge produced a Lowest Effect Level of 30% compared to 85% mortality in full strength effluent in 24 hours for fathead minnows. Less than an order of magnitude similarity between acute lethal results and sublethal or chronic values is common. Figure 3 plots also 0.25 of the LC50. It can be seen that for an effluent that is acutely lethal, the variability of the discharge is greater than the difference between acute and chronic information. Combining this with the relative cost of performing the two procedures results in the inescapable conclusion that for effluents of this quality, acute lethal tests are the most efficient monitoring tool. For effluents of better quality, the situation changes, because a point estimate of acute lethality may not be possible.

Sometimes we leave the impression that we are searching for the ideal toxicity test and, as soon as we find it, we will be able to drop all the others. Figure 4 compares trout acute lethality test results with acute lethality results to *Daphnia* on the same samples. A number of the points were LC50s of 100% or greater for

both animals. Of the rest of the points, notice that there are a number that were at 100% for one animal while less for the other. This lack of consistent trend in sensitivities suggests that the use of both of these tests is much more valuable than the use of one only.

6.1.3 Accomplishing the Task with Available Resources

There are less than a dozen individuals presently working in federal aquatic toxicity labs in Canada. The Aquatic Toxicity Unit of the Ministry consists of six which soon will become nine. In other provincial labs, there are probably less than half a dozen. The total is likely between 20 and 30 for the entire country. Completing more than two acute lethality tests on each discharger in the country with this work force would be difficult. Two acute lethality tests per year, if this were the way the people were be occupied, is not appropriate for a monitoring program on highly variable effluents. However, it would be a much more relevant frequency for auditing industrial self-monitoring. There is no point in having high ideals on a modest budgets.

6.2 THE POWER OF MAKING THE MOST OF THE DATA YOU GET

6.3 Who Needs to Understand Biological Tests?

A large part of the working lives of aquatic toxicologists in Canada has been spent in education of people directly working in the field of water pollution control on basic concepts of toxicity. How many times have we had to define the terms *LC50, acute, chronic etc.* This seems to be caused by people who refuse to study and retain this essential information. It is a waste of the limited number of toxicologists. If you are managing water quality, and you do not understand these concepts thoroughly you are not prepared to do your job adequately any more than you would be if you did not understand pH. There is no excuse for having to constantly have limited resources drained educating people on basic principles that they should have as part of their general knowledge. Water resource

managers must make a point of understanding the procedures and implications of biological tests.

6.3.1 The Need for Published Test Protocols

It is difficult if not impossible to have biological tests done by many people without establishing common methods in published protocols. The Ministry has for some time been using the same published protocol for static acute lethality test to trout and has recently published an official test protocol for *Daphnia magna* acute lethality.

6.3.2 The Management of Data Quality

Obviously, with the existing resources in aquatic toxicology in the federal and provincial laboratories, it is necessary to count on self testing by industry to adequately monitor effluents. Most, if not all, of the capacity should then be applied to an audit program. Even then, the audit program has to be a simple one to be evenly and fairly spread across all discharges. The Ministry's audit is expected to be made up of selected split samples with the industry or its contractors. We have rejected the use of lab accreditation since the quality of the results can slip before the ink is dry on the certificate. We also rejected the global use of reference toxicants, since these are not adequate for dealing with the great variety of effluent mixtures. If we had the U.S. Environmental Protection Agency's budget, we could consider a quality control program like theirs. Alas, we do not!

6.3.3 The Management of Biological Data

Toxicity data has a different structure than most chemical characterization data. Simply reporting the results as LC50s is inadequate. It is like describing *War and Peace* as a big book about Russians. In anticipation of receiving large amounts of toxicity data, the Ministry has developed a data management program called TOXDATA. This program permits the detailed and summary reporting of aquatic toxicity data.

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NON - CHEMICAL PESTICIDES

by
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Non-chemical pesticides, biological agents, bio-engineering, biotechnology, biotechnology pesticide products and organic farming, these are the present buzz words. To many people they promise a panacea for our pest problems in agriculture and forestry, in our gardens and even in our homes, without harm to humans or our environment. The perception of many members of the public is that all pesticides are "chemicals"; all chemicals are harmful or exceedingly hazardous; therefore, all pesticides must be abandoned. "Natural" non-chemical pest control methods - biological agents and biotechnology pesticide products - are seen as good (or safe).

Perhaps, before we proceed it would be appropriate to define a few terms that I will use.

"Pest" means any injurious, noxious or troublesome plant or animal life other than man or plant or animal life on or in man and includes any injurious, noxious or troublesome organic function of a plant or animal (Pesticides Act).

"Pesticide" means any organism, substance or thing that is manufactured, represented, sold or used as a means of directly or indirectly controlling, preventing, destroying, mitigating, attracting or repelling any pest or of altering the growth, development or characteristic of any plant life that is not a pest (Pesticides Act).

"Chemical Pesticide" means a substance obtained by a chemical process or used for producing chemical effect with a pesticidal result.

"Non-chemical Pesticide" means a substance which is a machine, apparatus, article, instrument, contrivance, gadget, living organism, metabolite, or other substance produced by naturally occurring or genetically engineered organism, or other biotechnology processes and parts of organisms with a pesticidal claim.

"Biotechnology Pesticide Products" means the result of the application of science and engineering to the direct or indirect use of living organisms, parts of organisms or products of organisms in their natural or modified forms to provide goods and services with pesticidal claims.

Pests have been around as long as man has been on this earth. The earliest records of attempts at pest control go back about four and a half thousand years in widely separated parts of the world. The Chinese and probably the Egyptians used chalk and wood ash for pests in structures. (Even today, wood ash is used as a deterrent to safari ants in East African villages).

Most early practices were, of course, based on superstition, folklore, or trial and error. During the 19th century, science became a more significant factor in pesticide product development, which consequently accelerated greatly.

Modern chemical pest control products and technology really date from World War 2 and later. In the 1940's and early 1950's the chlorinated hydrocarbon insecticides (DDT, aldrin, dieldrin, endrin, chlordane, etc.) and the phenoxy (hormone) herbicides (2,4-D, 2,4,5-T, 2,4,5-TP) were introduced. These products were characterized by their broad spectrum of pest control, low acute mammalian toxicity, and extreme persistence in the environment.

The next generation of chemical pesticides were the organophosphates (guthion, parathion, diazinon) in the 1950's. These chemical pesticides were also effective against a broad spectrum of pests, but were relatively non-persistent in the environment. In the 1960's the carbamates (carbaryl, carbofuran) began to enter the market. These chemical pesticides were highly toxic to a broad spectrum of pests and also degraded relatively quickly in the environment.

The 1970's and 1980's saw the withdrawal of most of the chlorinated hydrocarbons due to environmental impact, and a new generation of synthetic chemical, and some non-chemical pesticide, products were introduced. These products which included the pyrethroids and viruses were of low mammalian toxicity, specific to particular target pests, and non-persistent. But it was found that while some of these products may be safe to humans they can have a major impact on the aquatic environment.

Between the 1940's and the 1980's, efficacy was the major consideration. With the 1980's toxicological effects and environmental contamination became the overriding concern. The next few decades will probably be the era of non-chemical alternatives.

Attempts are already being made to reduce the amounts of chemical pesticides introduced to the environment, particularly in the agricultural sector but equally in all activities in which pesticides are used. The non-chemical alternatives can be broadly categorized as follows:

Agricultural Techniques: including different plowing and cultivation practices, and crop rotations. The gradual intensification of agriculture and the eventual monoculture of cereals, other crops and trees resulted in a great increase in the types and populations of pests. In agriculture, different plowing and cultivation techniques can decrease the amount of chemical pesticide used, but there are associated problems with increased labour and fuel costs, and increased erosion potential which could lead to phosphorus loading in our waterways.

Cultivars (Plant Varieties): include the breeding of new cultivars of crop plants to create those that have enhanced resistance to specific insect pests. It may also be possible to produce allelopathic varieties that have the ability to suppress competing weed seeds by secreting natural herbicides from their roots. (The Black walnut tree has this ability naturally).

However, recent breeding of new cultivars of zucchini to provide a better product for canning processes also resulted in selection of a naturally occurring toxin (cucurbitarcin) which is formed in very high concentrations. This new vegetable variety was found to be toxic to humans.

Natural Chemicals: include a wide range of products, such as pheromones, plant growth regulators and insect growth regulators. These are usually generically referred to as Biochemical Agents, and are naturally occurring chemicals (or identical synthetic chemicals) that are isolated or derived from natural biological sources.

In certain situations in confined areas insect growth regulators have been very effective e.g. Altosid which prevents the development of the mosquito larvae. However, many of these biochemical agents have not been very effective in the natural environment. This has been due to the agent not dispersing adequately and because the timing of the pest control measures is critical. Further, in the natural environment not all life stages of the pest population develop at the same time.

Biological Agents: include predators and parasites. Such pest control with insect counterpests as predators often involves species which specialize in feeding on or attacking a single target species. But it is essential that they should not be vectors of disease, and that their presence should not adversely affect the invaded ecosystem, other than, obviously, controlling the pest. Such an approach must be handled with care. Biological agents have already had their successes and failures. The eradication of the Screw worm, a cattle parasite, in the southern United States by means of the liberation of vast numbers of sterile males, and the control of the introduced Prickly pear cactus in Australia through the release of a species of moth which feeds on it, have been outstanding successes. On the other hand, control of the Med-fly in California unfortunately did not work. In Ontario, control of whitefly in greenhouses by the release of very small wasps which parasitize the pest is achieving excellent results.

Microbial agents: in the context of pest control, include not only bacteria, but also fungi, viruses and protozoans. These agents may be naturally occurring or genetically engineered organisms. Such techniques are analogous to biological warfare: to use a host-specific pathogen to bring the population of a pest under control. There are a large number of criteria to be considered for any microbial control agent.

Obviously, it must be selective for a specific pest organism, but there must be complete absence of adverse effects on man and any other non-target plant or animal life. There must be complete absence of any detrimental effects on water quality, and it should not bio-accumulate in non-target organisms. It should be easy to produce and easy to disseminate. But, and here we run head-on against one of the disadvantages of chemical pesticides, it should be self-maintaining when established; in other words, persistent. It should obviously be effective under the environmental conditions in which it is to be used. Lastly, it should be simple to assay for its presence in small quantities, both qualitatively and quantitatively.

Bacillus thuringiensis (Bt) and Leconte virus are two examples of microbial agents that have been successful although the timing of application is critical. Quite often it requires two or three applications to be successful due to a lack of uniformity in the development of the life stages of the pest. Thus, it is operationally more expensive than chemical pesticide control and microbials are presently almost impossible to monitor in the environment.

Integrated Pest Management (IPM) has been practiced for many years. It involves the use of a combination of all available means, cultural, mechanical, non-chemical and chemical, of combatting pests. In particular, great stress is laid on the monitoring of the pest population levels, so that control chemicals can be applied only when the population threatens to reach serious levels in the immediate future. With the introduction of new non-chemical pesticides, the emphasis on monitoring pest population and the integration of these new products will become even more important.

The Ontario Ministry of the Environment, through it's Ontario Pesticides Advisory Committee, administers an annual research fund ($400,000 per annum) which encourages the search for and the use of less toxic chemicals, and research on alternative methods of pest management. Over the past several years, there has been a major shift in funding towards research into non-chemical pesticide methods of control.

Now, I would like to address the regulation of pesticides in Canada and Ontario.

In Canada, legislation with respect to pest control products began federally in 1906, and in Ontario in 1936. All pesticides (chemical and non-chemical) must be registered by Agriculture Canada, under the Pest Control Products Act, acting with the advice of scientists of other federal agencies including Health and Welfare, Environment, and Fisheries and Oceans. Registration is granted after assessments of human and environmental health hazards, efficacy, environmental fate and many other aspects.

Subsequently, the Ontario Ministry of the Environment classifies and schedules each registered product, under the authority of the Pesticides Act, to control sale, use, storage, display, transportation and disposal. If it is considered necessary, its use may be limited to a licenced applicator or permit holder for specific cases.

The control of new biotechnology pesticide products present a whole new problem. The regulatory systems established by governments have been designed with chemical pesticides in mind. If, despite exhaustive testing, a chemical pesticide does not perform as expected, at least no more will be found in the environment than has been released. But now we will be looking, in many cases, at living organisms which can reproduce.

The information required for a biotechnology pesticide product or biological agent before it can be considered for registration is more complex, than for a chemical product. Most of the protocols and criteria for registration have not yet been formulated. For chemical pesticides, a great deal of laboratory acquired toxicity data is required, followed by field trials to establish data on acute and chronic lethality, reproductive effects and such effects as teratogenicity, mutagenicity and carcinogenicity. Finally, the environmental fate of the pesticide is assessed, including its residues, persistence and potential for bioaccumulation.

But for biotechnology pesticide products and biological agents this is only the beginning. In addition, laboratory data on strain history, pathogenicity and containment has to be compiled. In the field, the various aspects of pathogenicity have to be investigated, such as virulence, infectivity, host range and vectors. A wide range of genetic factors have to be categorized, and parameters concerning dispersal must be quantified. Ecological interactions must be systematically tracked down.

Since biotechnology pesticide products and biological agents differ significantly from chemical pesticides, the federal government is currently developing new criteria for the registration of these products under the Pest Control Products Act. Ontario has a well developed complementary program for chemical pesticides under the Pesticides Act, but it will have to develop criteria and protocols for the classification of these new products and agents under the Pesticides Act. This will necessitate the establishment of criteria and protocols for spills, waste disposal, issuance of permits for research trials, as well as the training and certification of applicators. These products also present a major challenge to researchers and regulators in measuring, and assessing, their impact on the natural environment.

Laboratory, in-vitro, experiments will give us many answers; but it is impossible to be sure what will happen in the field. If an agent happens to get out of control, how will we be able to manage it?

You may have heard through the media that the Premier, the Honourable David Peterson, announced on August 25, 1987, that the Ontario Government will be undertaking a comprehensive program to develop and implement alternative strategies for the effective control of pests. This program is known as Food Systems 2002, and aims to reduce pesticide use by 50% over the next 15 years. It will be implemented through the Ministry of Agriculture & Food and will focus on biological alternatives to chemical pesticides and the use of techniques such as Integrated Pest Management (IPM).

The implementation of Food Systems 2002 is accelerating the needs for our Ministry to develop the appropriate protocols and criteria to control these products and agents so that we have the beneficial uses while protecting human health and the environment. Above all, we do not want to trade the use of a chemical pesticide for an unknown and maybe equally hazardous substance produced through the use of a non-chemical pesticide.

EXPANSION OF STAMFORD/NIAGARA FALLS WATER POLLUTION CONTROL PLANT AND REDUCTION OF INDUSTRIAL LOADINGS

by
C. H. Eidt, Director of Engineering,
Regional Municipality of Niagara
Thorold, Ontario

The Stamford/Niagara Falls water pollution control plant was constructed jointly by the City of Niagara Falls and the Township of Stamford in 1961 and 1962. It was placed in operation in 1963, after the amalgamation of the two municipalities, to provide expanded sewage treatment service to the City of Niagara Falls. The consulting engineers were H. G. Acres International Limited and the plant was designed to provide primary treatment to a flow of 10 million imperial gallons per day. Sludges from the digesters were directed to lagoons where they were decanted. The material was later spread on adjacent land and air dried. The dried sludge was used for various agricultural purposes.

In 1975 the plant was physically doubled, Gore & Storrie Limited were the consulting engineers. Because of high storm flows during rain periods and phosphate removal requirements, the Ministry of the Environment rating of the plant was only increased to 12 (MIGD) million imperial gallons per day.

In January 1983, we received an inquiry from Mr. A. MacBain, then Member of Parliament for Niagara Falls, in respect to possible environmental projects in which the federal government could participate. We suggested the possibility of providing secondary treatment at the Stamford/Niagara Falls water pollution control plant. Our estimated cost for providing the facility at that time was in the order of $25 million.

Mr. MacBain was successful in obtaining a federal grant of $4 million and we approached the Province of Ontario requesting a similar grant. The province agreed to a grant of $3.85 million, providing we could develop a design and system with an overall capital expenditure of $12 million. The province also required that, in order to prevent overloading the plant, all food processing and beverage industries be required to reduce their discharge of overstrength wastes to sewer-use bylaw limits within a five-year period or by 1990. In 1983, the average flow at the plant was 12 MIGD with peak flows up to 23.5 MIGD on a maximum day.

We engaged the firm of Pollutech Inc. to undertake a process study to determine the most effective means of providing treatment for the sewage received. At the Niagara Falls plant, the sewage is quite normal for an eight- to nine-month period, but during the months of August, September, October, and part of November, strong sewage effluents are received from food and beverage industries. A procedure had to be developed to handle this shock loading. Pollutech Inc. undertook a three-month pilot plant program, between July 15 and November 17, 1983 and they developed data for waste characteristics.

They found the sewage from November through August to be similar to that found across the province for sanitary sewer systems. From August through November, the loadings increased extensively. Their rotating biological contactor pilot plant produced an effluent having both total $B.O.D._5$ (biochemical oxygen demand) and suspended solids of less than 15 milligrams per litre, operating on an organic loading of less than 2.2 lbs. of $B.O.D._5$ per 1,000 ft^2.

After very careful consideration of the technical report of Pollutech Inc. and their evaluation of various alternatives, it appeared that the most economic and best technical route was to proceed with rotating biological contactors for the plant. We therefore adopted this recommendation.

There were a number of installations in Canada; one in Guelph (tertiary only), several in Ontario and Saskatchewan, but they were quite small in comparison to our proposal, and are generally one-stage treatment. Our consultants and staff examined similar operations in the United States and it was our staff's opinion that we could make the system operate at the Stamford/Niagara Falls plant.

We encountered difficulty obtaining Ministry of the Environment approval for this project but because of the urgency of the Niagara River Toxics Committee report, which was then underway, and the publicity related to the availability of federal funding, we were given approval to proceed because of pressure from the minister's office. Our civil consultants were Gore & Storrie Ltd. and the successful contractor on this project was Pigott Construction. The construction consisted of 35 rotating biological contactor units, followed by secondary clarification and chlorination prior to discharge to the Ontario Hydro canal, which discharges to the Niagara River.

As a result of fast track construction, with able assistance of Gore & Storrie Ltd., we were able to take this project from conception to reality in two years.

As a condition of approval, the Ministry of the Environment required that food and beverage processing industries

reduce their suspended solids and B.O.D. loadings to the sanitary sewer system to our sewer-use bylaw limits within a five-year period (see Appendix "A"). We determined there were eight industries that fell into this category. These eight industries were issued control orders in 1984 requiring them to bring their waste discharges to the local sanitary sewer system in compliance with the Regional Municipality of Niagara Sewer Use Bylaw No. 3308-83 by 1990. Each industry was requested to provide a program for compliance by December 31, 1984. The program was to include a timetable giving specific dates for various phases under the program, such as design, tendering and construction.

The Niagara Region adopted its first Sewer-Use Bylaw in 1972. Like most sewer-use bylaws of this time, its main emphasis was on conventional parameters such as B.O.D. (biochemical oxygen demand), suspended solids, oil and grease, pH and a limited number of metals.

In 1976 this bylaw was revised to include a surcharge for companies whose wastes exceeded the bylaw's limits for B.O.D. and/or suspended solids and yet whose wastes could still be readily handled by the local sewage treatment plant.

This bylaw was primarily based on a model sewer-use bylaw developed by the Ontario Ministry of the Environment and the Municipal Engineering Association. As Niagara was also faced with the new "Provincial Guidelines for Sewage Sludge Utilization on Agricultural Lands", stricter controls on metals were also incorporated into the bylaw at this time. (See Appendix "A")

The current bylaw was adopted in 1983 in order to reflect minor changes in "The Regional Municipality of Niagara Act", which is the provincial legislation enabling Niagara to pass and enforce such bylaws.

It is believed that by mid-1988 the final version of a new model sewer-use bylaw will be received from the province. This bylaw will be the first attempt to address the public's concern for toxic chemicals, the majority being organic (carbon based) in nature.

Once this bylaw is reviewed, it will be incorporated with other changes currently under consideration by staff and submitted to our council for approval. One of these changes will likely include a substantially increased fine structure for offenders and the possibility of charging individuals if the enabling legislation is passed by parliament.

There is little doubt that the public's increasing awareness and concern with the accumulation of toxic chemicals in the environment, as well as our ever increasing knowledge of their effects, will require far more frequent bylaw revisions and much stricter methods of enforcement.

Before the control order was issued, Regional staff met with each of the industries to explain why a control order was necessary. In addition, the Regional Chairman, on June 4, 1984, sent a letter to each industry explaining financial requirements for sewage plant expansion and Ministry of the Environment requirements for industry to bring their effluent in compliance by 1990. He offered to arrange meetings

with a committee organized to attend such meetings. This committee consisted of representatives from Regional Council, including the Regional Chairman, Regional staff, City of Niagara Falls mayor and staff, and a representative from the Ministry of the Environment.

One of the very first complaints received from industry was that this requirement was not being made in other jurisdictions where their competition was located, and that they were being placed in an unfortunate position. Fortunately, the representative from the Ministry of the Environment was able to indicate that this was not the case and was of considerable assistance to us at these meetings.

The first industry, which was a beverage industry, objected very strongly to our order, particularly to the fact that we had not met with them previously. At our initial meeting, this firm rejected requirements of the control order. As a result of Ministry of the Environment input, they engaged consultants and by the spring of 1985, advised they were prepared to comply with our requirements. In 1988, they propose to call their consultants back in to determine if equalization of their wastes is now feasible. They have substantially reduced their waste discharge since receiving their 1985 consultants report and now believe they can comply with the sewer-use bylaw through equalization.

The second industry was a food industry. Upon receiving our control order, they employed a consulting firm and quickly determined that they were losing product which was causing their high organic discharge. As a result, in December 1984, they provided a report to us on an implementation reduction program through product recovery and re-use.

In checking with this firm on April 4, 1988, we discovered that the previous plant manager was no longer there. Staff at the plant admitted that for the past two years nothing was really done about the control order because of the possibility that the company might be sold. The new manager advises that they are now committed to an $8 million plant expansion and have hired a local engineering firm to prepare plans and specifications for pollution control in order that they may meet our control order by 1990, as previously promised.

The third firm was a beverage firm and upon receipt of our order, they engaged consultants to determine possible alternatives. At a meeting with our committee, they expressed concern with the cost tc provide additional inhouse treatment facilities and indicated it would make their operation less economical, forcing them out of business.

In checking with this firm on March 31, 1988, they indicated that they will continue to improve inplant control to reduce the amount of material discharged to the sanitary sewer system. They are planning a $1 million expansion and have included in their capital budget a lagoon in 1990 in order to meet our effluent requirements. A decision on whether to proceed with the lagoon or not will be made in 1989.

The fourth firm was a food processing industry and they initially ignored our order until a further letter was sent late in 1984. They expressed concern with the requirements in view of their poor financial position over the last few years. In 1985, they engaged a consulting engineering firm to carry out an engineering study and report on a program of compliance.

In checking with this firm on April 4, 1988, they advised that they had a new plant engineer and have provided $60,000 in their 1988 budget to engage a consulting firm which they hope will solve their problems. It is their opinion, that by improving their screening, they can reduce B.O.D. and by further plant improvement, they can meet our bylaw requirements. We requested that they put their proposals in writing so these can be reported to our Public Works and Utilities Committee.

The fifth industry was also a food processing firm. They immediately acknowledged our order, requested additional information and a copy of our consultants report. They wrote to our chairman in 1984, expressing concern about the cost of providing the necessary treatment. By December of 1984, they provided an outline of their effluent treatment proposals for complying with our bylaw by 1990. All of their work was done by inhouse staff.

By April 6, 1988, this company had gone as far as they could with chemical treatment (polymers and catalysts). They were still peaking at 1,400 milligrams per litre B.O.D., an average of 800 milligrams per litre B.O.D. The firm is now looking at separating their process streams and, where needed, treating them before they reach the dissolved air-flotating system. Also, they are examining screening wastes before they reach the wet well in order to prevent large solids from dissolving when the sewage is retained in the well.

This firm admitted they are facing a similar problem at their California plant and now realize that most of their problems with B.O.D. is due to blanchers because of high starch content (pasta). They are now consistently below the bylaw for suspended solids. They advise they will send us a further report on their activities in September of 1988.

The sixth industry was a food and beverage processing industry. Upon receipt of our order, they engaged a consulting firm. The industry was purchased by an international firm, who immediately advised that they would be in compliance with our bylaw by 1990. They indicated the course of action proposed. Unfortunately, because of marketing problems, this industry went out of business in 1987.

The seventh industry was a food processing industry which caused considerable problems in the past. They were purchased by a national industry and immediately reported to us on a program for compliance. They were almost in full compliance with our bylaw by 1985. They now propose to add a dissolved air flotation unit in 1988 in order to ensure that this will meet our bylaw requirements.

The eighth firm was a small food processing firm and they initially refused to co-operate with us. In February 1985, they wrote a letter to us advising they had nothing to report and that the estimate for compliance was a prohibitive cost for their company. They met and expressed their concerns to the mayor and local Members of Parliament and requested, through those sources, financial assistance.

On April 6, 1988, our staff contacted this firm again and they advised the Ontario Research Foundation has acquired technology on a type of membrane which will remove protein (solids), and that they are arranging for the system to be built in Canada. The manager advised that he was very pleased to find that he could actually sell the solids he recovered and apparently there is quite a market for these. He is quite satisfied that the equipment will do the job and agreed they will meet our bylaw by 1990.

By May 1987, the first firm had acquired other companies in Niagara region, and were working on a corporate policy. They advised that they had reduced their average B.O.D. and suspended solids by one-half and were introducing other measures. They have assured us that they will meet our bylaw by 1990.

Industry No. 2 carried out inplant measures to reduce waste loadings and it appears that their wastes are now within bylaw limits. Problems occurred because of staff changes, but with a proposed plant expansion, this will provide satisfactory equipment for pollution control.

Industry No. 3 hired a consultant and are considering their report. They indicated they want a further meeting with local political representatives and this will probably be arranged in the near future. It now appears they will build a lagoon in 1989 to resolve their effluent problem.

Industry No. 4 was debating whether to spend money on a pollution control system or close operations. It now appears with inplant improvements, that they will meet our bylaw.

Industry No. 5 did not hire a consultant but undertook considerable work with their own staff and are making progress. Since they are working on a similar problem at another plant in the United States, we anticipate they will solve their problems.

Industry No. 6 operated during 1986 but closed in 1987. Since they had a major impact on the pollution control plant, this certainly will reduce loading.

Industry No. 7, although giving us a very difficult time initially, is now in total compliance with the bylaw, 90% of the time. By 1990, they should be in compliance 100% of the time.

It now appears that industry No. 8 will be in compliance by 1990, provided they receive assistance they expect from the Ontario Research Foundation.

For testing of effluent, we request all industries in Niagara to do their own sampling and forward these samples to their own laboratory. We request that a copy of the test results be forwarded directly from the industry's selected laboratory to us. This information is used to determine surcharges where these are applicable and to assure that industries are meeting our bylaw requirements. We also request that all industries locate a manhole either at their property line or on the road allowance adjacent to their property, where we can take grab samples in order to monitor flows.

In general we found industries to be very co-operative, their sampling fair and objective; our system of allowing industries to do their own testing has worked out very well.

In October 1984, the report of the Niagara River Toxics Committee was made public. The Niagara Falls water pollution control plant was identified in the report of this committee as a source of priority pollutants at a rate of 24.3952 kilograms per day. As a result of provision of secondary treatment with rotating biological contactors, these priority pollutants have been reduced to 3.9001 kilograms per day, which is well within present allowable limits.

Construction of the pollution control plant was completed and it was placed in operation on December 20, 1985. We engaged Pollutech Inc. to provide us with one year of monitoring and to prepare a manual of instructions to properly operate the RBCs (rotating biological contactors).

The Rotating Biological Contactor (RBC) system is a rotating fixed film biological process that relies on biomass attached to a plastic media to extract soluble organic matter from the primary effluent. The soluble organics are converted to biomass by the living organisms through cell reproduction. The excess biomass is then sloughed off the media and collected in the secondary clarifiers. Oxygen, necessary to complete the biological process, is attained from the liquid media with alternate exposure of the biomass to the atmosphere and waste. This biological process is similar to conventional activated sludge in terms of biomass growth and harvesting, but differs in that biomass is "attached" not "suspended".

Primary effluent is fed to five (5) process trains and thereafter the influent is treated in a plug flow manner through four (4) stages of each train. Each shaft removes incremental amounts of soluble $B.O.D._5$ through conversion of organics to all biomass. The total RBC facility of 3,710,000 ft^2 can accommodate an organic load of approximately 8,160 pounds of $B.O.D._5$ per day at the 2.2 lb/1000 ft^2 load. The influent flow must be varied to ensure that the total organic loading is not exceeded on a continuous basis. Dissolved oxygen levels of 1.0 mg/L or greater in the first stage are a good measure that organic overloading is not being experienced.

To allow for optimized operation of the RBC facility during all periods of the year, we have an ongoing testing procedure on a monthly, weekly, daily and shift basis as follows:

-- monthly recording of weights on all 35 RBC shafts;

-- daily recording of weights on all Stage 1 RBC shafts;

-- daily recording of dissolved oxygen levels in all 35 RBC shafts;

-- shift recording of dissolved oxygen levels in all Shaft A, RBC units;

-- daily recording of visual characteristics of all shafts biomass as per established procedures

On initial start up, a complete inspection of RBC equipment was implemented. Media surface and joints must be checked regularly while initial biomass growth is occurring. We found that in our installation, sections of the media were loose due to improper sizing of the grommets used to anchor the media to the spider and shaft assembly. It is imperative that the units be revolving when raw sewage is introduced to the RBC trains, as an imbalanced situation on start up can occur very quickly. We find that this took less than two (2) hours. We experienced major motor problems, resulting in frequent motor repairs at startup. If any repair takes longer than two hours, maintenance staff rotate the RBC by hand one revolution per hour until completion of the job.

Motor failures experienced were due to little or no radial load on the non-drive end bearings. The motors have die-cast bearing castings with a steel sizing sleeve cast into the housing. This steel bearing seat is not a full circle. This means that the size of the bearing housing is controlled by a zinc die-cast casting. Given that the two metals have a difference in co-efficient liner expansion, it appears that an additional .001 inch of clearance develops in the bearing housing at operating temperature.

Several methods to rectify this situation have been tried including re-machining the housings and installing tolerance rings and also a complete replacement of non drive end housings. After endless correspondence and meetings with Regional staff, the manufacturer, U.S. Motors, finally agreed to a total replacement with a different motor. They supplied a heavy duty motor and it has solved this problem.

Referring to the process, we pay careful attention to biomass colour and odour as we found that the relationship between these factors, B.O.D. loading temperature and D.O.s (dissolved oxygen) are extremely helpful in determining the daily status of the system.

In conjunction with the Process Consultants, Pollutech, we experimented with the RBC system by introducing additional air in one train, step-feeding in another train and also regulating different flows for comparison in the remaining trains.

We also try to maintain a low sludge blanket in our final clarifier. We found by experience that returning sludge to the primaries was causing an overload situation at RBC sections. Hence, we pump our final clarifier waste directly to the digestors. This procedure will be reviewed with the process consultants after a year of experience.

Another problem encountered with RBC's was opposition from Ministry of the Environment staff. Perhaps it was felt that we used undue pressure in obtaining initial approval by meeting with the Minister of the Environment. After initial startup, Ministry of the Environment staff visited our plant. They were unduly critical of the operation and, in our opinion, without justification. We requested a further meeting with Ministry of the Environment staff, bringing in our consultants and our own staff to answer all questions.

Our staff and consultants were able to answer all questions and we demonstrated that our effluent met ministry requirements. The only problem they left with us was the fact that some members of the ministry did not like the colour of the algae strains within some of the RBC's.

Opposition of ministry staff surfaced in a speech made by the minister when he indicated there was an operational problem at the Niagara Falls plant. As a result, we sent the minister a report, prepared by our consultants, Pollutech, which indicated we were able to achieve the required effluent results in 1986 even with all food and beverage industries working at full capacity during the fall of 1986.

This problem was further discussed at Regional Engineers' meetings with senior staff of the Ministry of the Environment and, in my opinion, has now been resolved. Ministry staff are now much more willing to look at new ideas and new concepts and we have been successful in presenting and receiving acceptance of process studies at other plants where construction is proposed. This has resulted in both capital and operational cost savings for this municipality. We have found suggestions made by ministry staff very helpful and they are now most co-operative.

We were able to construct a plant with good operational characteristics; sensitive to operational requirements and providing improved effluent as required by the Ministry of the Environment's Certificate of Approval, at a minimum cost. By use of RBC's we have been able to reduce our initial estimated cost of $25 million to $12 million, to provide a plant capacity of 15 MIGD per day while still producing sludges which we can dispose of on farm lands, and an effluent well within the limits of our Certificate of Approval (that is an effluent objective of 15 parts per million B.O.D., 15 parts per million suspended solids, and 1 milligram per litre phosphorus with a non-compliance limit of 25-25-1).

With today's requirement for environmental approval and the need of keeping escalating costs down, it is very important that innovative ideas and processes be encouraged and not suppressed.

In summary, our experience was that governments and to some extent industries are suspicious of change. Industries, in many cases, cannot relate their discharges to municipal sewer systems, or to pollution as it exists in the Great Lakes ecosystem. Some believe tax-supported governments should solve all pollution problems without any disruption of manufacturing processes. We have proven that common sense negotiations and sensible guidelines can be sold to those who were most adamant. We have also proven that process studies pay off. It is well to remember that Ministry of the Environment guidelines are just that. They are not carved in stone, nor should they be tatooed on the minds of their officials. Process studies rarely fail to show the way. Because waste is as individual as the people who create it, methods of treatment can be just as varied. New technology will never have a chance without governments willing to become pioneers in pollution clean up. Thankfully, Ontario has accepted this challenge.

THE REGIONAL MUNICIPALITY OF NIAGARA

EXCERPT FROM
BILL 3271
SEWER USE BYLAW No. 3308-83

4. USE OF SEWERS:

(1) No person shall discharge into any Regional Sewage Works or into any sewer or sewer system connected directly or indirectly with any Regional Sewage Works, any matter or quantity of matter which may be harmful to or may become harmful to such sewage works, or which may interfere with their proper operation, or which may impair or interfere with any sewage treatment process, or which may obstruct or may tend to obstruct any sewer, or which may be or may become a hazard to persons, property or animals, or without limiting the generality of the foregoing, any of the following:

(a) sewage containing more than a total of 100 milligrams per litre of oil, fat and grease of animal and vegetable origin;

(b) sewage containing more than a total of 15 milligrams per litre of oil, grease and tar of mineral or synthetic origin;

(c) sewage at a temperature in excess of 65 degrees Celcius (149° Fahrenheit);

(d) subject to subparagraph (b) hereof, flammable or explosive matter, and without limiting the generality of the foregoing, gasoline, benzene, naptha, fuel oil, acetone or other solvents;

(e) any quantity of matter capable of obstructing the flow in or interfering with the proper operation of any part of the sewage works, and without limiting the generality of the foregoing, any such quantity of ashes, cinders, sand, straw, mud, shavings, metal, glass, rags, feathers, plastic, wood or cellulose;

(f) sewage having a pH less than 6.0 or greater than 10.5 or which due to its nature or content becomes less than 6.0 or greater than 10.5 within a sewage works;

(g) sewage of which the B.O.D. exceeds 500 milligrams per litre;

(h) sewage in which suspended solids exceed 500 milligrams per litre;

(i) sewage that may cause a nuisance, and without limiting the generality of the foregoing, sewage containing hydrogen sulphide, carbon disulphide, ammonia, trichloroethylene, sulphur dioxide, formaldehyde, chlorine, bromine, or pyridine, in such quantity that an offensive odour could emanate from the sewage works or could cause a nuisance;

(j) sewage containing animal waste, and without limiting the generality of the foregoing, containing intestines, stomach casings, intestinal contents, hides, hooves, toenails, horns, bones or poultry heads or sewage containing hair, wool, fur, feathers, paunch manure or fleshings in a quantity sufficient to interfere with the proper operation of the sewage works;

(k) any garbage, except from garbage disposal units or grinders, or any food waste which has not been properly shredded so that all particles will be carried freely under flow conditions normally prevailing in public sewers.

(l) sewage containing any of the following matter in excess of the indicated concentrations:

Matter	Expressed as	Concentrations in Milligrams per litre
Aluminum	Al	50
Arsenic	As	1.0
Barium	Ba	5.0
Cadmium	Cd	2.0
Chloride	Cl	1500
Chromium	Cr	5.0
Copper	Cu	5.0
Cyanide	HCN	1.0
Fluoride	F	10
Iron	Fe	50
Lead	Pb	5.0

Matter	Expressed as	Concentrations in Milligrams per litre
Mercury	Hg	0.1
Nickel	Ni	5.0
Phenolic compounds		1.0
Phosphorus	P	100
Sulphate	SO4	1500
Sulphide	S	2.0
Tin	SN	5.0
Zinc	Zn	5.0
Pesticides		0.0
Herbicides		0.0

(m) radioactive materials except as may be permitted under The Atomic Energy Control Act, R.S.C., 1970 and amendments thereto and regulations thereunder.

(n) storm water, water from drainage of roofs or land or from a watercourse, or uncontaminated water except that which may be discharged into a combined sewer.

(o) sewage which consists of two or more separate liquid layers.

(p) regardless of any limitations set forth in this bylaw, any quantity of matter which may hinder or prevent the disposal or application of sewage sludges on land due to limitations set forth in the current "Provisional Guidelines for Sewage Sludge Utilization on Agricultural Lands" as prepared by the Joint Ministerial Committees of the Ontario Ministry of Agriculture and Food, the Ontario Ministry of the Environment, and the Ontario Ministry of Health.

4. (2) If, in the opinion of the Director, an interceptor is necessary for the removal of grease, flammable wastes, sand or other harmful ingredients, such interceptor shall be in accordance with the standards and specifications of the Director and shall be in location easily accessible for cleaning and inspection.

Moderator: J. Bishop, Director,
Water Resources Branch,
Environment Ontario,
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D. Stevens,
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SOME APPROACHES TO SOLVING THE DOMESTIC WASTE MANAGEMENT DILEMMA

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Paper presented by Denis Stevens

Introduction

Waste generation, it's management, and ultimately it's disposal is indeed a dilemma - not only for Ontario but throughout North America and as recently experienced from our firms tour of European facilities, throughout most of the industrialized world.

Bill Goodings, who was scheduled to deliver this paper and whom, along with Dave Schram provided much of the information on the European approach to waste management could not be here today. Bill very much wanted to deliver this paper as it represents an opportunity for him to describe his philosophy on waste management. As a consultant and a practitioner in this field for over thirty years he has gained many insights and developed an approach which, followed could solve a lot of the problems which lead us to our current dilemma. He sends his regrets.

This presentation consists of an series of 35mm slides and a discussion of some approaches used to solve the domestic waste management problem. The paper is roughly divided into two parts. The first part deals with a broad picture of waste management and provides a bases for some of the later discussions. The second part focuses on the results of our European tour, undertaken by Bill Goodings and David Schram earlier this year. The paper concludes with insights and conclusions from both our European and North American ex-

periences in waste management. Most of the talk today will deal with municipal solid waste - the mixed, generally curb-side collected component from houses, apartments and from light commercial establishments. In Ontario this us usually handled by municipal collection.

Ontario disposes of roughly 10 million tonnes per year of municipal solid waste (MSW). This is of course a very rough estimate but it gives an idea of the scale of waste which produced and disposed of in a municipal waste system. In addition to municipally collected and disposed of wastes there are private haulers and private waste facilities which deposit wastes from both the public collection stream and the private waste stream. The numbers that I have indicated are generally exclusive of a large amounts of waste that are of special, commercial, industrial and other categories. Hazardous, liquid industrial and other special wastes are usually disposed of at dedicated sites are not considered in our discussion today. For a typically urban or suburban situation in Ontario, our rule of thumb is that 400 to 450 kg. per person per year of domestic waste can be expected to be generated. This figure may rise to approximately 1 tonne per person per year if all direct and indirect wastes are included in this per capita estimate. It's worth noting that the European rates generation, are generally considered to be approximately one third to one half of North American rates. At recent conference in Toronto, the differentiation between North American and European rates was discussed by a number of speakers. However, no explanation was offered for these differences. There was a slight generation rate drop in per capita figures in the early part of this decade. As we are aware 1980,1981 and 1982 were periods of economic distress. The upward trend of waste generation since the early part of the 1980's has continued at or above the levels experienced before the down turn in 1980 to 1982. Finally, by way of context Metropolitan Toronto, the largest urban center in Ontario is currently producing about 3.3 million tons of municipal solid waste per year.

The overwhelming majority of municipal waste generated and disposed of within Ontario is landfilled. A small portion is being incinerated and recent initiatives in recycling, for example blue box, will no doubt increase the percentage accommodated by recycling. The picture for in industrial and commercial side

of Metropolitan Toronto's waste stream is less precise. Although it is fair to say there is a much higher percentage of recycled or reused material in these waste streams the amount generated and the types of wastes reused and recycled are not precisely known. We believe that recycling within the industrial sector is generally higher on a percentage basis than on the domestic waste side.

The Ontario Dilemma

The Ontario dilemma, and the subject of this section of the Conference, as it relates to Waste Management it stems from two basic facts:

- The amount of waste generated is rapidly exceeding the capacity of current systems to dispose and manage it.

- The people of Ontario are less and less inclined to accept additional waste management facilities or to allow siting of the facilities used in managing and disposing of waste.

A number of municipalities in both southern and northern Ontario are experiencing severe problems because of limited waste disposal capacity. Metro Toronto is, for example looking at a severe short fall in capacity within the next 5 to 8 years. Given the vast amount of variety of wastes generated, a period of 5 to 8 years is a very short time. Metro's experience is reflected throughout Ontario in a number of communities which have landfills approaching capacity and very few other alternatives to disposing of their waste.

Ontario's waste dilemma is a result of a number of factors, for example:

Capacity:

In many instances the problem of capacity is central to the issue of waste disposal. It is compounded by the limited resources available for waste management. In the past waste management was not a high priority, both in terms of demand on time and on budgets in many of the towns and cities across the province. It is only in the last 5 to 10 years that waste issues have increased in

intensity. In the agricultural, suburban and urban environments of southern Ontario and even in more rural central and northern Ontario waste generation is increasing and the space for locating waste management facilities is more difficult to find. The public no longer accepts, without reservation the need for the traditional disposal options or their siting - particularly if close to dwellings, businesses or recreational areas.

Resources:

The cost of waste management has increased. Financial resources are under strain in many areas. Traditionally, the rates for disposal of wastes were generally less than $10 per tonne. Rates have jumped dramatically in recent years. Although many recent increases are the result of policy considerations, the actual cost of landfilling including approvals, operations, increase in standard of design, and closure costs have increased three to four times previous levels. Currently Metro has increased their rates at landfill to $50 per tonne. This is being matched by many other municipalities in the area. The cost of exporting waste for to privately run facilities is also much higher. All of these changes put a severe strain on financial resources of the municipality. Municipal staff time and resources to deal with the problem of waste management have also experienced higher demand.

Approvals and Planing Cost:

The approval process of waste management invariably involves both the Environmental Protection Act and the Environmental Assessment Act. In addition there are an increasing number of other statutes and approvals which are required before a facility or a waste management system can approved. There is no need to go into any detail or discussion regarding the length and time and cost of approvals for waste management facilities; we are all familiar with the problems that waste disposal applications produce within our own communities. For example the consolidated hearing for the Halton Region Landfill is establishing a new record time for a completion. The cost of this hearing by all accounts is very high and the time and resources of Halton Region staff have been substantial. It is a reasonable expectation that in future hearings will con-

tinue to be very long complex affairs as all of the stakeholders influenced by waste management decisions demand a role and a voice in any approvals process.

Public Dissatisfaction:

Public dissatisfaction is a topic that needs no introduction. There are many examples of public opposition to waste management facilities. The public in general, special interest groups, and lobby groups will have a strong bearing on the course of approvals. Intervenors are generally more sophisticated, better prepared and well financed. The results of their involvement is a demand for greater detail and sophistication in the planing of waste management facilities. This adds time and expense to approvals. As a major ingredient of Ontario's dilemma in waste management the public, is both a major influence and in many respects a victim of the waste problem.

Diversity of Choice:

Finally there are a great variety of choices available for managing waste. This has not always been the case. As a result of the variety of choices and the higher standards if sophistication more and more trade-offs are becoming necessary and the decision on waste management facilities is becoming less obvious. New technologies, or reworked older technologies are continually presenting themselves for consideration. The variety and types of wastes making up the waste stream is much greater. The current legislation requires that all alternatives be considered in at least initially to satisfy the requirements of the environmental planing statutes. There are some clear benefits from the increased sophistication in waste management. However, public and review agencies understanding of many of the limitations of new technologies contributes to the time and effort to get approval. More choices with a greater number of trade-offs invariable results in a more confused situation.

These points are some of the major ones that we conclude are important contributing factors to the garbage dilemma. For the purpose of our discussion today they cover the range of problems that must be solved if we are to deal with the growing difficulty of disposing of our solid wastes.

Range of Approaches

To begin to solve Ontario's waste management dilemma we start by identifying the different approaches to waste management that should be considered for evaluation. We can look at the experience of our own jurisdictions and those of other countries.

The waste system can be viewed as three integrated parts:

- Waste collection and transport.
- Sorting and processing.
- Waste disposal.

Although there is often a jurisdictional split between agencies responsible for the collection of waste and it's ultimate processing, sorting, or disposal the system as a whole has got to be considered to ensure that sound management in an efficient waste management system results.

Within the area of collection there are a number of alternatives which are currently in use. These include :

- Curb side collection of mixed solid waste .
- Depot collection of mixed solid waste.
- Curb side collection of separated solid waste.
- Depot collection of separated solid wastes.

A number of combinations of these four categories could be found in a given system. The purposes of this discussion these four categories will suffice. As the analysis of the collection component of Waste Management becomes more detailed the range of materials, with types of collection containers, sorting of

waste into separate streams all figure importantly in determining the most effective means of dealing with municipal waste collection phase. We will discuss these in more detail later.

For the waste processing and disposal phases of the waste management system we have identified the following list of approaches that are usually considered:

- Reuse and recycling.
- Materials recovery.
- Composting.
- Energy Recovery.
- Refuse Derived Fuel Production.
- Landfilling.
- Export.

In addition there are a number of esoteric technologies that have been proposed. It is our experience that they contribute very little by way of disposal capacity. They are often directed at specialized materials or unique situations. The order of priority of waste management approaches generally stresses waste reduction, reuse and recycling, with landfilling and export considered the lowest priority.

Waste reduction initiatives are usually considered the most important and effective means of reducing the amount of waste needed to be recycled reused or disposed of. In terms of the range of approaches that could be used to help solve our waste dilemma it clearly the approach of choice. Strictly speaking however, it is not a waste disposal or a waste processing technique. In fact it can be argued that it is not a waste management technique per se as it deals with materials before they become wastes. It is a means of reducing the potential of products of the manufacturing and processing stream to become a waste problem. Notwithstanding, it is very important objective within any municipality to reduce the amount of solid material that will have to be collected, processed

and disposed of in the waste management system. In our discussion today we will assume that even the best reduction programs will leave plenty of waste to be disposed of or reprocessed.

Systems Analysis

Having identified a number of approaches to waste management i.e. techniques, facilities or programs that could be used to manage waste, the next stage is to determine the best combination of approaches for a given study area. Proctor & Redfern is currently undertaking a systems analysis toward this end for Metro Toronto. We have labeled this "The Hierachical Analysis". This is because the evaluation that we use is based upon a ranking or prioritizing of each approach within a given system of waste management. With a knowledge of waste composition, combinations of waste management approaches can be tested using criteria dealing with a potential system's: environmental suitability, operational needs, costs, safety, government policy directives and guidelines and a number of other important factors. Different wastes (for example scrap metal, kitchen wastes, white goods, newsprint, cardboard and so forth) can be directed towards the most appropriate waste processing or disposal alternative. The interrelationship of the range appropriate techniques, waste management technologies and programs (such as waste reduction) then comprise the waste management system.

Without going into detail our preliminary conclusions in Metro Toronto's case indicate that aggressive reduction and recycling programs combined with source separation of household and light commercial wastes into two or three streams seems the most appropriate "front end" to the waste management system. Once the municipal solid waste has been segregated into wet, dry, and/or specified recyclable streams the appropriate combination of technologies can be applied to reduced the emphases on land filling and provide a socially acceptable end products. Our preliminary analysis also indicates that techniques such as composting will play an important role in modern waste management systems. Landfilling, although still required will play a much lesser role in the managing and disposing of solid wastes.

We've given you a rather brief and very abbreviate overview of the nature of the waste management dilemma particularly as they relates to solid wastes in Ontario. In addition we have given you a brief discussion of the range and alternatives that have been considered and the types of analysis that have been undertaken to provide an appropriate waste management system. A lot of detailed analysis which takes into account the composition of the waste stream, the materials available and the state into which they are collected and of course the alternatives used to process each of the components. At this stage we will describe some of the experiences that Bill Goodings and Dave Schram had in Europe. The general approach used in waste management in Europe is instructive for the Ontario situation. Most of my discussion in the following second half of this presentation will revolve around a series of slides.

The European Experience

In the spring of this year Bill Goodings and Dave Schram of Proctor & Redfern's Waste Management Group toured a number of facilities in Europe. The tour was arranged with considerable amount of research on our part to allow us to see the most important and significant waste management systems. The European tour concentrated on the experience in Belgium, Germany, Austria. In addition one or two plants were visited the United Kingdom. The emphases of the tour was to update us on the advances in Europe in handling wastes through a composting processes and dry wastes through recycling. There is no "blue box" system per se in Europe. Rather, most countries use a number of segregated bins which are associated with households and, depending upon the nature of the wastes, in depots or in public plazas and shopping centers. It is a system that works very well that we think can be adapted to Canada. (The following is a brief description of the slides presented):

1 The Wet/Dry Approach

The major features of the wet dry collection are separation of householder of all waste into dry and relatively clean and wet and relatively dirty fraction. Wastes are not specified for each, rather householder judgment upon which constitutes wet soiled wastes versus dry recyclable waste is relied upon.

2 Example of Wet/Dry Bins

This is an example of the large, plastic, closable containers showing the wet wastes in the gray bin and dry waste in the green bin.

3 A Semi-Automated Collector

This automatic truck pick-up demonstrates collection of wet or dry wastes.

4 Example of Dry Waste Disposal Into Bin

Dry waste are deposited by each house holder into the appropriate green bin.

5 Example of Wet Wastes Into Bin

In this slide wet yard waste (clippings and leaves) are deposited into the closed gray container by the householder.

6 Commercial Bin Pick-Up by Semi-Automative Equipment

Demonstrated is a larger unit in a commercial setting automatically loading dry wastes.

7 A Depot System

Paper, glass, metals etc. are deposited in depots in some localities.

8 Glass Depot System

White glass and coloured glass are separated into the appropriate containers at local collection depot.

9 Depot System for Three Materials

White and coloured glass, paper, cardboard and metals are illustrated.

10 Backyard Composting

A typical backyard compostor is demonstrated as used by householders.

11 A Battery Collection Depot

Regular flashlight batteries and a smaller more hazardous mercury batteries have special red bins at most commercial plazas and retail centers. In some countries in Europe new batteries can not be purchased without the old batteries been turned in or exchanged at the same time.

12 Example of Special Collection Days

European style household hazardous waste programs are undertaken regularly, generally by private sector contractor. Time periods range from two weeks to yearly.

13 Automated Pick-Up of Special Waste Collection

Fully automated systems and lifts on trucks are used to collect special wastes (generally hazardous).

14 Plant Showing Typical Tipping Floor

Typical tipping floor for collected dry wastes via a conveyer system is demonstrated in a German plant.

15 Separators

Slides showing the magnetic separators and picking lines to segregate dry wastes from mixed wastes to trommel sorting of the dry waste stream.

16 Hand Picking of Recyclables

Slide shows demonstration of hand picking along conveyers lines for recyclables; the negative picking process.

17 Hand Picking on a Circular Belt

This is a demonstration of a worker picking selected wastes from a circular belt in a German plant.

18 Further Examples of Belt Picking

19 Hand Sorting of Dry Waste

20 Example of a Composting Facility

This is an example of a smaller windrow facility in Austria showing what wastes in composting windrow under cover. Windrow compost piles under a roof with a negative air forced system, 80 days cycle, illustrated.

21 A Twenty Four Hour Fermentation Kiln

A hundred and twenty foot long fermentation kiln is used to ferment wet wastes in a plant in the Rhine Valley. (Minimal separation used in this system, some size reduction of materials).

22 Inside the Fermentation Kiln

A slide shows the inside of the fermentation kiln showing internal blades used to mix the waste

23 Waste Composed Product

This is an example of a local farmer picking up the coarse compost for application on steep hills on slopes in vineyard production.

24 Belgium Windrow Plant

A Beuhler Miag plant in Belgium demonstrates the preparation of windrows after the wet wastes have been separated.

25 Demonstration of a Mobile Turning

26 Turning of Windrows

27 Screening of Compost Products

The slide illustrates a screen used for the final clean-up compost before preparation for bagging.

28 Bagging of Compost

Bagging of the end product coming from the compost plant is illustrated.

29 Application of Compost

An agricultural illustration of the use for composting in Europe is demonstrated, a widely used and highly desirable product.

30 Land Application of Compost

This shows further illustration of compost used in Europe.

The slides illustrate a number of facilities in waste treatment processes in Europe. The basic collection system used there is what is known as a Wet/Dry system.

The Wet/Dry System

Source separated curbside pick-up and the use of depots for specialized waste such as household hazardous waste and some commercial waste is the basic system in much of industrialized Europe.

Householders are issued green and gray bins; the green bin for the dry fraction of domestic waste and the wet bin for the soiled wet fraction. These containers are fairly large and usually accommodate up to several weeks garbage. The householder is asked to make one choice when disposing of garbage. If it is wet, soiled and generally soiled or contaminated with wet organic residues, it is placed in the gray container. Wastes that are generally put in the green bin are suitable for recycling, however, unlike our blue box system they are not specified. This technique has the advantage of allowing the householder to make just one decision when disposing of his wastes under each of the two tightly sealed large volume containers. There is no requirement to memorize a list of acceptable wastes or potentially recycled products for separate pickup. Hence, there is less opportunity for cross contamination or for failure to include a specified material in the refuse stream.

Pickup times for the wet/dry system vary with jurisdiction. The periods between pickup, however, are usually much longer than in Ontario. Pickup of wet wastes may be once or twice per month for example. The design of the container usually prevents the escape of odours or the loss of material through spillage. Dry waste pickup ranges from once per week through longer periods up to

once per month. Wet and dry wastes are generally collected on different days. The participation rate of residents in the wet/dry system is generally very high. A system based upon coercion or penalty is not used; rather wide advertising, the force of custom and, where necessary, peer pressure are usually applied to ensure that recalcitrant residents participate. As indicated during the slide presentation, household hazardous wastes, for example batteries and other special wastes are put in different coloured containers usually at depots or public places.

Wet wastes are usually composted. Dry wastes, once picked up, are delivered to sorting plants where they are separated into product or material streams for subsequent processing, reuse, recovery, or disposal through incineration or landfilling.

It's surprising to note that although Europe has achieved an enviable reputation for waste conservation and recycling, many of the plants who were producing compost end up landfilling their product. Residues of refractory or unuseful materials from both the wet stream and the dry stream are often landfilled. Incineration is another means of waste disposal that is widely used in Europe, often with energy recovery. For example, the costs of electricity are usually higher and the industrialized nature of the landscape makes direct application of heat energy for industrial uses a convenient option.

The unique features of the European system revolve around the wet/dry source separation collection approach to municipal solid waste and the emphasis on composting as a safe, environmentally appropriate method of recycling organic rich materials. The processing of dry recyclables such as metals, glass and paper differs from the North American experience primarily in the degree to which it is practiced and the influence of the European market on waste dry products. In Europe, with fewer natural resources and a higher population in a more urbanized setting, recycling of domestic, commercial and industrial waste is greater. From a technological point of view, however, there appears to be little difference in the way in which wastes are separated, reprocessed and recycled when compared to what is done in North America.

A technical overview of the the solid waste facilities visited on the European tour and a summary of cost information are included in two tables from the Appendix.

Conclusions

The overview of waste management systems planning, some of the factors involved with Ontario's garbage dilemma and a slide presentation on the European tour particularly as it relates to their approach to waste collection and the significance of composting has been necessarily brief. There are, however, a number of basic conclusions which can be drawn from this information. All of them are important in terms of Ontario's future treatment of waste and are examples of feasible alternatives to waste management in this province. The conclusions are as follows:

1. Vertical Integration

Waste collection, sorting, processing and shipping and waste disposal or reuse are integrated closely in the European approaches to waste management. Long-term contracts with representatives of the private sector are standard; these invariably involve periods of five to ten years. There is strong legislative support for the integration of the waste processing stream. Often, various private sector firms will look after different components of the waste materials stream and cooperate with one another in the collection, delivery and sorting of constituent materials.

2. Private Sector Initiative

As indicated, private sector facilities and private sector involvement is high in the European waste management systems. Waste collection processing reuse is not subsidized. There is a strong legal, educational and policy framework to support and encourage waste recycling and conservation, however, all the

components of the waste stream are integrated and cost effective in their operations. Private sector initiatives are encouraged and markets are developed on a long-term basis.

3. Comparable Costs

The costs of waste collection disposal relate well to the Canadian experience. In general, there are far fewer subsidies in solid waste management. There are legislative incentives to encourage the use of waste materials. More importantly, there are no built-in incentives to discourage the use of waste materials in terms of processing or in the use of waste derived products. Because of private sector involvement and the lack of subsidies, waste collection processing and disposal is done in a very cost-efficient way. Markets are well established.

4. Dependence on Landfill or Incineration

Incinerators and landfills are still the major component of European waste management systems. In general, because of land availability, incineration is far more common in Europe than in Ontario. Energy recovery is, as expected, a feature given Europe's relative lack of oil and hydroelectric generating capacity. Landfills and incinerators are constituents that are important parts of the system. They are not considered external to it. As indicated during the slide presentation, products from some waste management systems in certain municipalities are routinely landfilled after composting or recycling. However, the climate for this is gradually changing. As in North America, the role of landfill and the role of the incinerator is necessary, however, it is becoming less and less appropriate from the public's point of view. The changing attitudes in Europe are not dissimilar to those attitudes in North America.

Relevance to Ontario

Ontario's garbage dilemma is not unique to this province. It is part of the overall problem of waste disposal and waste management throughout the world. As countries become more affluent and as the transportation of goods becomes more feasible, the requirements for the range and number of material goods has increased.

Packaging prevents particular challenges whether it be from the increased use of plastics or the evolution of newer forms of combined materials such as "tetra-packs" for disposable drink containers. Although in Europe there is a tendency to move away from plastic and back into glass, the additional costs associated with glass recycling, the additional weight of transport and inconvenience of handling glass packaged materials may be a trade-off that this country is not prepared to make. It is apparent, however, that there are some developments in Europe which are particularly relevant to Ontario.

In summary, we would conclude that a system which allows the maximum separation of waste at the curb-side is more appropriate than one relying upon the highly mechanized, centralized source separation. The curb-side separation should be as comprehensive as possible. The European wet/dry system is particularly appropriate in this regard. At the very least, an extension of the current blue box approach to recycling more materials would seem to be highly appropriate.

Need for an integrated system is required. At this stage, we may not have to make the choice between the private sector versus the current public sector role. Regardless of the operator of the various components of the waste management system an integrated system is far superior. A feature of the integrated system is, of course, the availability of long-term contracts which allow the establishment of markets and the capital purchases of equipment and facilities.

Finally, of the range of facilities examined in Europe, it is clear that composting is an important waste management approach. As a rule, composting has not been well developed in North America. Although there are a number of initiatives in the U.S. and composting on a backyard or small depot scale has been tried in Metro, the approach has not been widely used. Composting can be costly if co-mingled domestic waste is received, however, if organic rich wastes in a wet stream are directed towards composting facilities, many of the problems and much of the cost is reduced.

Again, this demonstrates the importance of an integrated system involving the collection, sorting, processing and ultimate disposal of wastes. Composting technology is proved. It has the advantages of being essentially odour free, environmentally safe and cost effective. The product of compost which is a usable stable humus can be applied to a range of commercial and private uses.

Finally, it bears repeating that there are no pat solutions to the waste management dilemma. A gradual change in public attitude and the participation of all stakeholders in the waste management system will be required before the dilemma begins to be solved. There are a wide variety of choices available for managing municipal solid waste, commercial and industrial waste and special wastes. If the European experience is any indication, there are some important lessons that can be learned that appear to be entirely feasible in Ontario.

APPENDIX

TABLE 1 **Technical Overview of European Facilities**

TABLE 2 **Cost Overview of European Facilities**

TABLE 1

TECHNICAL OVERVIEW OF SOLID WASTE FACILITIES
FACILITIES VISITED - EUROPEAN TOUR
MAY 2ND TO MAY 7TH, 1988 (B. GOODINGS AND D. SCHRAM)

Type of Facility (Years of Operation)	Owner/Operator and Contacts (Years of Experience)	Days and hours of Operation	Location (Population Served)	Setting and Adjacent Land Uses	SYSTEM OVERVIEW (% of Total Waste) Tonnes Recycled (Percent)	Tonnes Incinerated (Percent)	Tonnes Composted (Percent)	Tonnes Landfilled (Percent)	Facility Capacity (No. of Employees)	Frequency of Residential Waste Collection
Dry Waste Processing Facility. Wet and Dry Collection and Yard Waste Composting (2 years)	Schoenmackers GmbH Dr. Karlheinz Scheffold (33 years)	5 days per week 8 hours per day	Town of Kempen in north-west West Germany (1.6 million people serviced)	Industrial Park. Light industrial and service industries are neighbours	35,000 tonnes glass, paper, (2 grades) cardboard, ferrous metal (15 percent) Rejects to landfill range from 15 to 20%	47,000 tonnes of residential (20%) and commercial/ industrial waste (20 percent)	3,000 tonnes of yard waste delivered by residents (>1 percent)	153,000 tonnes 50 percent of residential waste (65 percent)	100 TPD. Processes 35,000 TPY, including 15% Commercial solid waste. (15 employees in waste processing plant - $8/hour average)	Residents serviced by wet and dry collection every two weeks on alternate weeks.
Paper Waste recycling facility. Dry Waste recycling	Grumacher Recycling GmbH and its engineering division Sutco Alfons Grumacher (President). Thomas Schmitz and Carlos Ramirez from Sutco (35 years)	5 days per week 8 hours per day	Town of Overath in central West Germany (250,000 people serviced)	Industrial Park. Neighbours include transport company, heavy industrial	24,000 tonnes of newspaper, fine paper and cardboard. Municipal glass and metal depot (igloo) system recycles about 12,000 tonnes (10% of total waste). (30 percent) Rejects about 5 to 10%	Recovered plastic to cement kiln - demonstration burn (RED-I-MIX) (>1 percent)	-----	96,000 tonnes 75% of residential waste (70 percent)	120 TPD. Processes 24,000 TPY. Primarily residential solid waste (12 employees)	Dry waste once a month. Wet waste 3 of 4 weeks.
Hollmeyer GmbH (collection and processing) SULO (equipment suppliers, designers and manufacturers) (30+ years in waste collection) Ronald Keele Reinhart Wist and Jurgen Neuhaus	Dry waste recycling process facility (primarily paper) transfer station and wet/dry collection (2 years)	5 days per week 8 hours per day	Osnabruck in central West Germany (300,000 people serviced)	Rural area. Adjacent to inert waste landfill	Facility processes about 20,000 tonnes of paper grades. Municipal depot system recycles about 20,000 tonnes of glass and metal (20 percent) Rejects are about 5 percent	----	----	160,000 tonnes (80 percent)	200 TPD, but process about 100 TPD. Primarily residential waste. (12 to 20 employees)	Green bin (paper only) once per month Grey bin (all other wastes) 3 times per month

Type of Facility (Years of Operation)	Owner/Operator and Contacts (Years of Experience)	Days and hours of Operation	Location (Population Served)	Setting and Adjacent Land Uses	SYSTEM OVERVIEW (% of Total Waste) Tonnes Recycled (Percent)	Tonnes Incinerated (Percent)	Tonnes Composted (Percent)	Tonnes Landfilled (Percent)	Facility Capacity (No. of Employees)	Frequency of Residential Waste Collection
Altvater and SULO. SULO has 25 years of composting experience. Michael Herken	Mixed Waste composting facility featuring a fermenting kiln (1 year)	5 days per week 8 hours per day	Bad Kreuznach in the Rhine Valley, West Germany (140,000 people served)	Industrial park. Adjacent to sewage treatment plant, tire manufacturer, other heavy industrial uses and U.S. Air Force Base	Paper and ferrous metal recycled Municipal depot system for glass and metal waste. Total recycled 18,000 tonnes (10 percent)	----	60,000 tonnes. Three grades of compost produced plus landfill cover (35 percent) Rejects 5 to 10 percent	100,000 tonnes About 30% of residential waste (55 percent)	200 TPD. Processes primarily residential solid waste and about 10% septic wastes and some paper mill wastes (16 employees)	Grey bin - mixed waste once per week
Jakob Becker KG B. Liese and Mr. Becker. (80+ years)	Dry waste processing and wet/dry collection system (6 months)	5 days per week 6 hours per day	Semach in Central Germany (170,000 people, 83 villages served)	Rural area. Close to U.S. Air Force Base	9,600 tonnes of paper, cardboard, metal and glass recycled (35 percent)	----	Demonstration project will be initiated.	18,200 tonnes about 70% residential (65 percent)	50 TPD Processes primarily residential waste (20 emplyees)	Green and Grey bins collected on alternate weeks

TABLE 2

**OVERVIEW OF REPORTED COSTS (REPORTED IN CDN $)
OF SOLID WASTE FACILITIES VISITED
EUROPEAN TOUR, MAY 2ND TO MAY 7TH, 1988**

(B. Goodings and D. Schram)

Type, Location and Owner/Operator of Facility	Reported Capital Cost of Facility	TIPPING FEES (PER TONNE)				REVENUES (PER TONNE) AND MARKETS						Length of Contract
		At Facility	At Landfill	At Incinerator	At Other	Newspaper, Paper and and Cardboard	Glass	Metal	Compost	Other	Collection Cost	
Dry waste processing and demonstration yard waste composting. Schoonmakers	$2 million (5,000 sq. metres and processing equipment) Cost of Collection Bins - $35	$15.00	• 2 sites 1. $20.00 2. $30.00	$35.00	Free - yard waste composting	• $30.00 (paper) • $75.00 (card-board) Paper mill in Netherlands	$45.00 (colour separated) Germany	$30.00 Germany	$20.00 when market is available. Local	$0.05 to $0.07 per kw/hr for electricity. Local	$5.00 to $8.00 per capita per year depend-ing on level of service provided	12 years
Mixed dry waste processing. Grunaecher	$1.5 million (75,000 sq. metres and processing equipment)	$30.00	$30.00	—	—	• $35.00 (paper) • $90.00 (card-board) Local Mill	—	—	—	—	$3.50 per capita per year	15 years
Huttemeyer GmbH and SULO	$3.75 million including transfer station (200 TPD) - 75,000 sq. metres	$14.00	$14.00	$60.00 will increase to $100.00	—	• $30.00 to $50.00 (4 grades of paper) • $110.00 (brown cardboard) • $90.00 (printed cardboard) Paper mill in Netherlands	—	—	—	$16.00 landfill diversion credit	$6.00 per capita per year	12 years
Alwater and SULO	$22.5 million 2 hectare site	$60.00	$40.00	—	—	• $25.00 (news-paper) • $75.00 (card-board) Local mill	$15.00 (mixed) Germany	$60.00 Germany	$9.00 to $13.00 depending on grade of com-post. Area grape growers	—	$6.00 per capita per year	20 years
Jakob Becker	$2.25 million 4 hectare site about 35,000 to 40,000 sq. metres	$10.00	$15.00	—	—	• $35.00 (paper and newspaper) • $80.00 (card-board) Local, Netherlands and Norway	$48.00 (mixed) Germany	$28.00 Germany	—	—	$5.00 per capita per year. Collec-tion and $19.00 per capita for processing	15 years

MUNICIPAL WASTE DISPOSAL PROBLEMS AND PROPOSED SOLUTIONS

by

W. G. Crowther, Project Manager,
Solid Waste Environmental Assessment
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Toronto, Ontario

- On January 1, 1967, by amendment of the Metropolitan Toronto Act, Metropolitan Toronto assumed responsibility for the disposal of solid waste generated within Metro. The collection of municipal solid waste remains the responsibility of the Area Municipalities. At that time, municipal disposal facilities consisted of seven incinerators.

- However, in the knowledge that changes in the waste disposal situation were impending, Metropolitan Toronto Council engaged consultants in March, 1966, to formulate a plan for the management of solid waste generated within the Metropolitan Planning Area. The consultants concluded that the most practical approach to solid waste management in the Metro area, was sanitary landfill and municipal incineration.

- In the examination of existing incinerators, it was determined that only the existing Commissioners and the Ingram Incinerators were suitable for inclusion in the waste management plan, together with the Dufferin Incinerator, which was still under construction at the time of the consultants' report. The plan which was officially adopted in principle by the Metropolitan Council, included:

- o - the acquisition of three new major landfills at an early date;

  - the use of two existing incinerators and the one under construction at that time; and

  - the construction of six new transfer stations.

- o Since 1967 incineration has been largely phased out. The last operating incinerator, Commissioners Street is scheduled to be closed on July 1, 1988. That facility was ordered to be closed by Metro Council, in response to public health concerns, even though the result of risk assessment studies currently underway were not yet available.

- o The current system consists of 7 transfer stations and two landfills. At present, waste which is received at the Symes, Disco, Ingram, Bermondsey, Victoria Park and Dufferin transfer stations is hauled to our Keele Valley Landfill Site in the region of York. The Brock West Landfill Site in the region of Durham receives wastes from the Scarborough Transfer Station as well as municipal and industrial

commercial waste from that region and industrial/commercial waste from Eastern Metro.

There are also two private sector transfer stations in Metro.

- In the region of Durham there are four small municipal landfills and two municipal transfer stations, as well as one private sector landfill. However, approximately 75% of the regions total waste is disposed of in Metropolitan Toronto facilities.

- In the region of York there are, in addition to the Metropolitan Toronto Keele Valley Landfill, three small municipal landfills and one private sector transfer station. However, approximately 95% of all waste generated in the region is disposed of at Metropolitan Toronto facilities.

- In 1967, 488,529 metric tonnes of solid waste were disposed of at Metropolitan Toronto facilities. By 1987 that amount had increased to 3,250,703 metric tonnes. Waste received to date in 1988 is approximately 8% higher than that for the same time in 1987. As can be seen from the graph, the rate of growth in waste handled had been relatively constant throughout the period from 1967 to approximately 1983, but since that time has increased dramatically.

- Of the 3,250,000 metric tonnes disposed of by Metro in 1987, approximately 40% was domestic waste, a further 10% was waste from miscellaneous municipal operations, boards and commissions, and the remaining 50% was industrial/commercial waste.

- There are many factors which have contributed to this large increase in waste handled by Metro since 1983. Three landfills, two in the Region of York and one in the Region of Durham closed during this period. Prior to their closure, these three sites had been receiving a total of 450,000 tonnes per annum. This waste is now processed for the most part at Metro facilities.

- During the period 1981 to 1986 population in Metro, York and Durham increased by approximately 150,000, with the number of people living in Metro decreasing from approximately 80% to 76%. By the year 2001, a further increase in population of approximately 500,000 is expected to occur in the 3 regions with the percentage residing in Metro decreasing to 66%. Since on average within the Metropolitan area, each man, woman and child generates approximately 1 tonne/refuse per annum, the overall rate of generation can be expected to increase by approximately 500,000 tonnes over that period.

- Similarly, employment in Metro, York and Durham increased by 50,000 jobs between 1981 and 1986, with the number of jobs within Metro decreasing from 86 to 81 per cent. By the year 2001 a further 350,000 jobs are expected to be created within the 3 regions, with the percentage within Metro decreasing to 77 per cent.

- Throughout most of last year, and until May 1st, 1988 when Metro raised its fees to $50.00/tonne, tipping fees in the Regions of Peel and Halton were significantly higher than those at Metro Toronto facilities. Although it can not be quantified precisely, it is estimated that as much as 100,000 tonnes per year of waste from Peel and Halton was brought to Metro facilities in 1987.

There has also been considerable improvement in the overall economic climate of the area during this period and, although it cannot be accurately quantified, the increase in consumer spending translates into increased industrial/commercial production and as a result increased waste generation.

o At the same time that Metro was being faced with tremendous increases in annual tonnage, it found itself in a situation where its approved remaining landfill capacity was reduced by approximately 50 per cent.

This graph traces the inventory of approved remaining landfill capacity held by Metropolitan Toronto since 1967. Two sites, the Brock North and Brock South sites in the Region of Durham, with a combined total disposal capacity of 12 million tonnes, had been approved under a public hearing process and Certificates of Approval issued in the mid 1970's. As well, Metro was party to an Agreement with the Region of Durham, agreeing to joint use of those sites upon completion of the Brock West Site. As such, we had always considered these sites to represent a secure reserve capacity, which in 1985 (when we began the process of updating the Master Plan) was considered to be sufficient to see us through the interim period of Master Plan preparation, prior to approval of additional disposal capacity.

However, in 1987, we were advised by the Metropolitan Solicitor and outside legal counsel retained by the Corporation, that the existing certificates for those sites were invalid (and that the sites could not be used) without full hearings under the Environmental Assessment Act.

As can be seen from this graph, at the present rate of filling, capacity at the existing Brock West Landfill will be exhausted by 1990, and capacity at Keele Valley by 1992. Assuming a 7M tonne interim landfill (equivalent to Brock South) site were available to replace Brock West upon its closure, Metropolitan Toronto disposal capacity could be extended to 1994. However, approval of a new interim site in that time frame would require a full or partial EA exemption.

- If an exemption from the EA Act is not granted so as to permit development of an interim landfill site in a timely manner, then Metro could be without disposal capacity as early as 1992.

(describe scenario's on graph).

In light of the above, on June 10, 1988, Metro Council authorized the Metro Works Department to seek an exemption from the requirements of the EA Act, for the development of an interim landfill site to serve Eastern Metropolitan Toronto and the Region of Durham, for a period of 5 years while the search for additional landfill capacity, and the evaluation of alternate waste management technologies, and the immediate implementation of recycling programs is underway through the master plan process.

o That, in a nutshell, is the situation facing the Metropolitan Works Department today. Many have alluded to it as a crisis or a looming crisis. Many have criticized the Department for poor planning, many have accused us of having manipulated the situation to attempt to circumvent the regulatory process, while others claim that by embracing recycling at an earlier date, the existing situation and the need for additional landfill could have been avoided.

- It is the position of the Metropolitan Works Department that these charges are unfounded. Until deletion of Brock North and Brock South in 1987, all waste management system planning, including the need for additional disposal capacity and master plan updates, had been predicated upon the use of the Brock North and Brock South sites, which had been first identified as disposal sites in our 1967 Master Plan and re-affirmed for use in subsequent Master Plan updates in 1976 and 1980 and in Agreements with the Region of Durham dated 1970 and 1978.

- While it is true we have been somewhat slower in implementing blue box recycling programs than some of our neighbouring regions, we estimate that even if Metropolitan Toronto had implemented blue box programs Metrowide 2 years ago, the completion date of the Brock West Landfill would have been delayed by only one month.

- Where is Metropolitan Toronto going in waste management today? To answer that, we must go back to a process which began in 1985. At that time, 5 years had elapsed since completion of Metro's last Master Plan, and consideration was being given to its updating. Coincidentally, at that time the Region of Durham had just completed its own Solid Waste Management Study, one of the recommendations of which was that the Region pursue long term use of a Metropolitan Toronto Disposal facility.

Subsequently, in February 1986, Metro Council approved initiation of a joint site search with Region of Durham, simultaneously with an updating of Metropolitan Toronto's Master Plan.

Hoever, during September 1986, the joint search was suspended by Metro Council until the need and rationale for a landfill site could be documented in accordance with the requirements of the EA Act, and consultants were engaged to carry out an Appraisal Study, setting out the strategy to be followed by Metro in carrying out a Master Plan under the Environmental Assessment Act. This study also included a separate report justifying the need for some landfill capacity as an essential component of any plan.

- The appraisal study was received in December 1986, and in March 1987, funding for the first two years of the Master Plan Work Program was approved. This work included initiation of a landfill site search, the evaluation of alternate Solid Waste Management technologies and engagement of temporary staff.

- Work on the Master Plan which is known as SWEAP, (Solid Waste Environmental Assessment Plan), began in May 1987, and is being performed partly-in-house by departmental staff seconded from other duties and temporary contract staff and partly by consultants.

  The process is being carried out by Metropolitan Toronto in association with the Regional Municipalities of Durham and York, with a view to establishing a Solid Waste Management Plan not just for Metropolitan Toronto, but for the three regional municipalities.

- As is the case with other master plans, the study will identify the most acceptable systems for the handling, reduction and recycling, transportation, processing and disposal of solid waste generated within the area of study. It will examine waste reduction, source separation, and material and energy recovery as well as a comprehensive review of all waste management options, & integration with other solid waste management plans.

As you are all aware, because of the level and detail of study required to prepare and support a master plan submission, and the approvals process to which it is eventually subject, approval of the plan and implementation of certain components or facilities may not occur for several years.

However, SWEAP is also an action plan. Environmental concerns have become a major issue in today's society, and effective waste management techniques, to deal with the ever increasing quantities of waste are required right now, and cannot await completion of the Master Plan. From an environmental and public perspective, the 3 R's, reduction, re-use, and recycling are considered to be the most acceptable methods of waste management.

- Input received from the public through the Master Plan process, indicates that Waste reduction, the prevention of waste at the source of generation, is the first priority for action. Packaging is a major contributor to the large quantities of waste requiring disposal. It is estimated that almost one-third of Metro's municipal waste stream is comprised of packaging and containers.

- A recent report prepared for the state of New York indicates that the per capita generation of packaging waste in New York is expected to increase 25% (from 720 to 900) pounds per capital from 1987 to 1997. To reduce the amount of solid waste being generated, Federal and/or Provincial legislative measures will be required, which will impose basic changes on the way materials are manufactured and sold.

- Legislative measures such as banning or placing additonal taxes on packaging that present disposal problems, is one method of effecting change. For example, legislation could be passed that bans fast food outlets from using plastic containers and, requires them to serve their product in packages that can be recycled or are biodegradable.

- A tax system could be effective by placing a tax or surcharge on all packaging, but waiving this tax if the packages are made of material that can be easily recycled. Legislative measures of this nature are obviously beyond the authority of Municipal or Regional governments. While these measures may sound atttractive from a waste reduction point of view, they must be weighed against a host of other concerns related to the economy, employment, and trade.

- Re-use refers to the use of materials again in their original form rather than disposing of them. Examples include donating used clothing and furniture to charitable organizations, and using refillable bottles.

- Greater use must be made of public education programs that promote waste reduction and re-use.

- These efforts can focus on making consumers more aware of overpackaging, and attempt to change consumer purchasing behaviour, for example, buying cloth diapers instead of disposables, replaceable razor blades as opposed to disposable ones, and purchasing food in bulk instead of individually-wrapped portion packs.

Changes in purchasing behaviour can also be extended to larger consumers. For example, on February 3, 1987 the Metropolitan Corporation adopted a positive procurement policy for re-refined waste oil if it meets grade specifications, and is no greater than 5 per cent above the price of oil manufactured from virgin resources.

While the logic of reduction and re-use is compelling, there are as of yet few proven tools, particularly at the municipal and regional level, that have effectively reduced the quantity of waste requiring disposal.

- The third R, recycling, is where significant waste diversion can be achieved at the municipal or regional level. Recycling refers to the recovery of materials from the waste stream for use as a replacement for virgin materials, when manufacturing new products.

- To date, municipal recycling in Metropolitan Toronto has not accounted for a major diversion of waste from landfill and incineration. However, this situation is rapidly changing. In 1986, approximately 18,000 metric tonnes or 1.7% of the total municipal waste generated was recycled. In 1987, this amount increased to 25,000 metric tonnes or 2.4% of the municipal waste stream.

- As many of you are likely aware, the Metropolitan Corporation has recently undertaken a number of recycling initiatives. These initiatives include the provision of funds, services and information, to encourage and facilitate the implementation of recycling programs in Metropolitan Toronto.

The Metropolitan Corporation provides a comprehensive Funding package which includes diversion credits, a Start-Up Contribution Program, and an Operating Cost Subsidy for multi material curbside collection programs.

On October 11, 1985, Metro Council approved a recycling diversion credit payable to the Area Municipalities for removing waste for recycling. The current diversion credit is $16.00/tonne.

In 1987, over $300,000.00 was paid to Metropolitan Area Municipalities for diverting waste. As in most jurisdictions, the diversion credit was originally targeted at the traditional recyclable materials of newspapers, glass and metal cans. However, it has been extended to other materials, such as white goods and municipally composted leaves. The amount of the credit is reviewed annually, to assess its effect on the quantities of material recycled.

- On March 31, 1987, in an effort to encourage Metropolitan Area Municipalities to implement class 1 multi material curbside programs, Metropolitan Council approved a "Start-Up Contribution Program" to assist the municipalities in the initial capital outlay required to initiate such programs.

  The start up program is part of a combined fund contributed to equally by Metropolitan Toronto, The Ministry of the Environment and OMMRI.

  In 1988, Metropolitan Toronto's start-up contribution will be $1,600,000.00. A further $600,000.00 is anticipated in 1989.

- In addition to the recycling diversion credit and start-up contribution program, Metropolitan Council on December 8, 1987, authorized payment of an operating subsidy to its Area Municipalities, to cover net operating costs that would be incurred by implementing the blue box program. The estimated cost to the Metropolitan Corporation of this operating subsidy is estimated at $5,000,000.00 over the next five year period.

As a result of these initiatives, blue box programs will be operating in five Metro area municipalities by this fall with the remaining municipality coming on-line early in 1989.

Approximately 1.5 million residents in 450,000 households will be served by the programs, which will collect newspapers, glass containers, aluminum and steel cans, and plastic soft-drink containers. It is estimated that these programs will recover approximately 60,000 tonnes of waste materials annually from Metropolitan Toronto.

- In 1987, 5 of our Area Municipalities operated leaf composting programs in selected collection areas. The total 1987 collection was 4600 tonnes.

- If these programs are expanded to all areas of Metropolitan Toronto and if suitable space for composting operations can be found, it is estimated that 20,000 tonnes of leaves can be diverted from landfill annually.

- In 1987, 3 Metro municipalities recycled Christmas trees into wood chips for use in municipal parks. Expansion of this program Metro-wide is being encouraged, and could result in a further annual diversion of 500 tonnes.

- At present, 5 Metro municipalities have also implemented programs which recover white goods for recycling.

- The white goods, which are generally included in special pick-up programs for bulky articles, are collected separately and delivered to a a scrap metal dealer. Assuming markets continue to be available, it is estimated that current recovery levels could double, resulting in an annual diversion of 2,000 tonnes.

Full implementation and expansion of these recycling programs, most of which are in progress or imminent, will result in an immediate reduction in the municipal waste stream of close to 9 per cent, by 1989. As municipal solid waste represents one-third of the total waste received annually at our facilities, this is equivalent to a reduction of 3% in our overall waste stream.

- Multi-material recycling in apartments, and the backyard composting of residential food and yard waste, are two other areas that are being developed as S.W.E.A.P. evolves.

- In this regard Metropolitan Toronto is currently sponsoring a home composting demonstrations project at the Toronto Islands.

- However, these types of programs are in a preliminary developmental stage compared to residential blue box programs, and a number of barriers need to be overcome prior to successful implementation.

- A realistic time frame for full implementation is possibly three years, and would result in an additional annual diversion of 60,000 tonnes. When combined with the blue box, leaf and white goods and Christmas tree program, the result would be a 15% reduction in the municipal waste stream or 5% of the total waste generated, by the year 1991. The operation of similar programs throughout the Regions of York and Durham would increase this overall rate to between 7 and 8%.

- At the present time, the Metro Works Department arranges for the sale of newspapers collected curbside by the City of Toronto, and assists in providing transportation to markets. This marketing service is available to all of our Area Municipalities, and will be expanded to include other secondary materials such as glass and metal, to be generated from the Area Municipalities blue box programs. Materials generated from these programs will initially be received and processed at our Ingram, Scarborough and Disco transfer stations. It is our expectation that expansion of the common marketing service, provided by the Metropolitan Corporation, will increase negotiating strength and revenue in the secondary materials marketplace.

On September 29, 1987, Metropolitan Council approved the implementation of a permanent program by the Metropolitan Works Department, to receive and provide proper disposal for household hazardous wastes, at six Works Department locations in Metro, York and Durham. Certificates of approval have been issued for 5 of the 6 proposed permanent sites and operations are expected to begin shortly. It is estimated that approximately 40,000 litres and 1,500 kg of household hazardous waste will be received annually.

- A number of initiatives have also been undertaken by Metropolitan Toronto to facilitate increased recycling of industrial waste. These initiatives to date have focused on providing industry with information and support to undertake recycling programs.

Under the Recycling Opportunity Notice Program, personnel at Metropolitan Toronto disposal facilities visually inspect loads of incoming waste, and identify any loads that contain a high concentration of recyclable material. Metropolitan Toronto's Industrial Waste Reduction Co-ordinator then contacts the hauler and generator, encourages them to recover future loads of such material for recycling and, assists in locating a market for the recyclable material. The Works Department has also developed a working relationship with the provincial and federal waste exchanges, to increase industrial waste abatement in Metropolitan Toronto.

?

- The Metropolitan Toronto Works Department is also currently negotiating with two private firms, for the operation of commercial and industrial waste recycling projects at the former Provincial Experimental Resource Recovery Plant, now owned by the Metropolitan Corporation. These projects include the recovery of old corrugated containers, and the composting of organic waste from industry. It is estimated that approximately 6,000 tonnes per year of OCC and up to 50,000 tonnes per year of organic waste could be diverted from landfill through these initiatives.

- There are, however, still significant quantities of potentially recyclable industrial and commercial waste that are being disposed of. Further recovery of corrugated cardboard, composting of organic waste from industry, expansion of office paper programs, recycling of tires and an extension of our industrial waste reduction program to include waste audits and exchanges, are all initiatives that are currently being considered by the Metropolitan Corporation. While we are unable to accurately quantify these initiatives at this time, it is expected that they will have a significant impact on the amount of industrial and commercial waste requiring disposal.

As well, the recent increase in Metropolitan tipping fees is also expected to have a significant effect over time on the amount of industrial/commercial waste requiring disposal. Effective May 1, 1988, tipping fees were increased from 18 to $50/tonne at landfill, from 32 to $65/tonne at transfer stations.

o In closing, effective waste management planning involves the establishment of an optimal and realistic mix of approaches. Reduction, re-use and recycling can play a significant role in managing our waste stream, and efforts are being made to implement programs as soon as possible however, they do not provide a panacea to the entire waste disposal problem. This graph illustrates the known quantifiable amount of municipal recycling which can be accurately predicted to occur at this time, which as you can see is a relatively small portion of the overall waste stream. The principal benefit of recycling, reduction and re-use is to reduce the amount of solid waste which must be disposed through the traditional methods of landfill and incineration.

It should be stressed that no amount of reduction, re-use and recycling will eliminate the requirement for landfill. Landfill will always be required for:

- municipal solid waste which can not be recycled or incinerated
- residuals from other waste management facilities

- materials which cannot be processed at other waste management facilities due to equipment failure or exceedance of capacity

- incinerator ash

- street sweepings

- wastes from sewage treatment plants

- demolition and construction waste

- The problems confronting solid waste management officials today are not without technical solution. Perhaps one of the greatest problems which we in Metropolitan Toronto have encountered and must overcome, is in the area of public attitude and education. The general public must be made to understand the nature of the solid waste management problem to which they are contributing and their role in its solution. They must accept the fact that their active participation is required in recycling programs such as the blue box, in separating household hazardous waste from other refuse for proper handling and disposal. They must be prepared to accept higher costs for solid waste management resulting from the implementation of more expensive and capital intensive waste management technologies as well as from

possible special taxes and charges which may be required to ensure materials are recovered and reused. Above all, they must accept that the proper management of solid waste will require the siting of waste management facilities within their communities.

PUBLIC REACTION AND POSITION

by

Norah Stoner, MPP, Durham West,
Ajax, Ontario

Mrs. Stoner spoke from notes and personal experience. A text of her address was not available for incorporation in the Proceedings. Should additional information on her subject and comments be required, it is suggested that the author be contacted direct at her office, Legislative Building, Queen's Park, Toronto.

WASTE MANAGEMENT OPTIONS FOR METROPOLITIAN TORONTO

by

Richard Gilbert, Alderman,
Metropolitian Toronto,
Ontario

Alderman Gilbert spoke from notes and personal experience. A text of his address was not made available for incorporation in the Proceedings. Should additional data on his subject and comments be required, it is suggested that the author be contacted direct at his office, City Hall, Metropolitian Toronto.

THIRTY-FIFTH ONTARIO WASTE MANAGEMENT CONFERENCE

Toronto Prince Hotel
June 12-15, 1988

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M5J 2L1

Adams, T.B.
Lever Brothers Ltd.
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M4M 1B6

Adams, V.
Sunoco Inc.
36 York Mills Rd.
North York, Ontario
M2P 2C5

Alter, L.M.
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Inco Ltd.
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Banwell, C.
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L2R 7B3

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L1G 1K7

Chant, D.A.
Ontario Waste Management Corp.
2 Bloor St. W.
Toronto, Ontario
M4W 3E2

Chart, E.J.
Maclarentech Inc.
2235 Sheppard Ave. W.
Willowdale, Ontario
M2J 5A6

Cheong, L.
Giffels Associates Ltd.
30 International Blvd.
Rexdale, Ontario
M9W 5P3

Cheetham, M.F.
Ministry of the Environment
7 Overlea Blvd., 5th Fl.
Toronto, Ontario
M4H 1A8

Choma, J.A.
City of London
P.O. Box 5035, Rm. 1006
London, Ontario
N6A 4L9

Clark, D.
M.M. Dillon Ltd.
47 Sheppard Ave. E.
Willowdale, Ontario
M2N 5X5

Clearwater, S.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Coates, D.
M.C.S. Ltd.
Box 1779
Bracebridge, Ontario
P0B 1C0

Coburn, J.A.
Zenon Environmental Inc.
845 Harrington Crt.
Burlington, Ontario
L7N 3P3

Cocchiarella, E.
Dofasco
P.O. Box 460, Stn. A
Hamilton, Ontario
L8N 3J5

Coleman, N.D.
CN Rail
277 Front St. W., Ste. 504
Toronto, Ontario
M5V 2X7

Coles, C.
St. Lawrence Cement Inc.
2391 Lakeshore Rd. W.
Mississauga, Ontario
L5J 1K1

Collins, G.
J.M. Schneider Inc.
321 Courtland Ave. E.
Kitchener, Ontario
N2G 3X8

Condlln, F.
Region of Peel
10 Peel Centre Dr.
Brampton, Ontario
L6T 4B9

Constantine, T.
MacLaren Engineers
2235 Sheppard Ave. E.
Toronto, Ontario
M2J 5A6

Cook, J.D.
Esso Petroleum Canada
55 St. Clair Ave. W.
Toronto, Ontario
M5W 2J8

Corbu, O.
Dept. of Regional Industrial Expansions
1 Front St. W.
Toronto, Ontario
M5J 1A4

Crabtree, P.
Ministry of the Environment
40 St. Clair Ave. W., 6th Fl.
Toronto, Ontario
M4V 1M2

Craig, B.
General Motors of Canada Ltd.
1901 Eglinton Ave. E.
Scarborough, Ontario
M1L 2L8

Crimi, K.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Crocker, D.
Ministry of the Environment
135 St. Clair Ave. W., 11th Fl.
Toronto, Ontario
M4V 1P5

Cunningham, D.
Cyanamid Canada Inc.
P.O. Box 240
Niagara Falls, Ontario
L2E 6T4

Daniels, L.
Ontario Waste Management Corp.
Industrial Rd. & Hwy. 20
Smithville, Ontario
L0R 2A0

Davey, S.
Environ. Science & Engineering
10 Petch St.
Aurora, Ontario
L4G 5N7

Davison, W.G.
Photo Engravers & Electrotypers
2250 Islington Ave.
Rexdale, Ontario
M9W 3W6

Dawe, R.
Tricil (Sarnia) Ltd.
R.R.#1
Corunna, Ontario
N0N 1G0

Dawson, C.W.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

deJong, B.D.
Tricil (Sarnia) Ltd.
265 N. Front St., Ste. 502
Sarnia, Ontario
N7T 7X1

Deshevy, R.
City of Barrie
165 Ferndale Dr., Box 647
Barrie, Ontario
L4M 4V1

Dhars, S.
Ministry of Municipal Affairs
777 Bay St., 11th Fl.
Toronto, Ontario
M5G 2E5

Dickson, D.T.
Du Pont Canada Inc.
P.O. Box 2100
Kingston, Ontario
K7L 4Z6

Dobson, A.
Metropolitan Toronto Works Dept.
439 University Ave., 10th Fl.
Toronto, Ontario
M4C 1Y8

Dochstader, J.
Environmental Mgt. Corp.
2128 River Rd.
London, Ontario
N6A 4C3

Donnelly, K.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Douglas, P.
Mosaic Chemical Corp.
5369 Maingate Dr.
Mississauga, Ontario
L4W 1G6

Drowley, W.B.
MacLaren Engineers
2235 Sheppard Ave. E.
Willowdale, Ontario
M2J 5A6

Duffus, G.S.
Westinghouse
120 King St. W., Box 510
Hamilton, Ontario
L8N 3K2

Duncan, C.E.
Ministry of the Environment
880 Bay St. S., 4th Fl.
Toronto, Ontario
M5S 1Z8

Durham, F.N.
Ministry of the Environment
985 Adelaide St. S.
London, Ontario
N6E 1V3

Durisin, L.
Technical Service Lab
1301 Fewster Dr.
Mississauga, Ontario
L4W 1A2

Earl, D.
Ministry of the Environment
135 St. Clair Ave. W.
Toronto, Ontario
M4V 1P5

Edmunds, K.
Intergrated Explorations
189 McCurdy Rd., Box 1385
Guelph, Ontario
N1H 6N8

Edwards, S.
Totten Sims Hubicki
1500 Hopkins Rd.
Whitby, Ontario
L1N 2C3

Effer, W.R.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Eidt, C.H.
Regional Municipality of Niagara
2201 St. Davids Rd.
Thorold, Ontario
L2V 4T7

Eisler, H.
Stelco Inc.
P.P. Box 2030
Hamilton, Ontario
L8N 3T1

Faust, J.
City of Windsor Public Works Dept.
P.O. Box 1607
Windsor, Ontario
N9A 6S1

Ferguson, R.
Metropolitan Works Dept.
439 University Ave., 10th Fl.
Toronto, Ontario
M4C 1Y8

Fisher, A.D.
Jagger Hims Ltd.
92 Davis Dr., Ste. 203
Newmarket, Ontario
L3Y 2N1

Fisher, J.
Steetley Industries Ltd.
R.R.#2, 447 Moxley Rd. S.
Hamilton, Ontario
L9H 5E2

Fizcere, L.
Waste Management Branch
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Flynn, T.
McDonnel Douglas Canada Ltd.
P.O. Box 6013
Toronto AMF, Ontario
L5P 1B7

Foggett, R.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Forest, S.
Chrysler Canada
P.O. Box 1621, CIMS 233-02-17
Windsor, Ontario
N9A 4H6

Fracassi, A.
Philip Enterprises Inc.
52 Imperial St., Box 423, Stn. B
Hamilton, Ontario
L8L 7W2

Fraser, J.A.
Indusmin
365 Bloor St. E., Ste. 200
Toronto, Ontario
M4W 3G4

Fricker, B.W.
Brydor Ltd.
P.O. Box 115
Don Mills, Ontario
M3C 2R6

Fyfe, J.
Falconbridge Ltd.
Edison Bldg.
Falconbridge, Ontario
P0M 1S0

Garden, S.
Environment Canada
25 St. Clair Ave. E.
Toronto, Ontario
M4T 1M2

Gardiner, E.
Ontario Mining Association
111 Richmond St. W., Ste. 1114
Toronto, Ontario
M5h 2G4

Gascoigne, L.
Recovered Chemicals
404A Old Kingston Rd.
Scarborough, Ontario
M1C 1B7

Gayford, J.W.
Ford Motor Company of Canada
Canadian Rd.
Oakville, Ontario
L6J 5C9

German, R.B.
MacLarentech Inc.
2235 Sheppard Ave. W.
Willowdale, Ontario
M2J 5A6

Gibson, R.
Ministry of the Environment
7 Overlea Blvd., 4th Fl.
Toronto, Ontario
M4H 1A8

Gilbert, R.
Metropolitan Toronto
10 Queen St. W.
Toronto, Ontario
M5H 2N2

Glenn, B.
Corpus Info Services
1450 Don Mills Rd.
Don Mills, Ontario
M3B 2X7

Goldby, H.
WMI Waste Management of Cda.
55 Fenman Dr.
Weston, Ontario
M9L 1M4

Goodings, W.
Proctor & Redfern Group
45 Green Belt Dr.
Don Mills, Ontario
M3C 3K3

Gorber, D.
Senes Consultants Ltd.
52 West Beaver Creek, Unit 4
Richmond Hill, Ontario
L4B 1G5

Gough, E.
Northern Development Council
R.R.#2
Magnetawan, Ontario
P0A 1P0

Gleeson, M.
General Motors of Canada
215 William St. E.
Oshawa, Ontario
L1G 1K7

Glover, B.
IWT-HIMSLEY INTERNATIONAL
250 Merton St., Ste. 305
Toronto, Ontario
M4S 1B1

Gray, I.
Ministry of the Environment
12 Fairview Rd.
Barrie, Ontario
L4N 4P3

Green, L.B.
Kodak Canada Inc.
3500 Eglinton Ave. W.
Toronto, Ontario
M6M 1V3

Greenfield, M.
Dofasco
1330 Burlington St. E.
Hamilton, Ontario
L8L 4K7

Greenshields, J.
Suncor
P.O. Box 307
Sarnia, Ontario
N7S 2N2

Greig, B.
Chem-King Inc.
125 Ferndale Dr.
Barrie, Ontario
L4M 4S4

Grenier, J.
A Johnson (Canada) Inc.
9050 Ryan Ave.
Montreal, Quebec
H9P 2M8

Griffiths, R.
Ontario Waste Management Corp.
2 Bloor St. W.
Toronto, Ontario
M4W 3E2

Grondin, L.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Gruner, A.G.
ACG Technology Ltd.
2175 Dunwin Dr. #5
Mississauga, Ontario
L5L 1X2

Guglielmi, T.
J.M. Schneider Inc.
321 Courtland Ave. E.
Kitchener, Ontario
N2G 3X8

Guillaume, F.
Proctor & Redfern Group
45 Green Belt Dr.
Don Mills, Ontario
M3C 3K3

Haasz, T.
Metropolitan Works Dept.
439 University Ave., 10th Fl.
Toronto, Ontario
M4C 1Y8

Hamilton, M.
Tricil (Sarnia) Ltd.
265 N. Front St., Ste. 502
Sarnia, Ontario
N7T 7X1

Hansen, P.L.
Chrysler Canada
Box 1621
Windsor, Ontario
N9A 4H6

Hansler, B.
Ministry of the Environment
119 King St. W., 12th Fl. Box 2112
Hamilton, Ontario
L8N 3Z9

Harper, R.
Alchem Inc.
1055 Truman St.
Burlington, Ontario
L7R 3Y9

Harris, R.C.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Hart, C.
Parliamentary Assistant, MOE
135 St. Clair Ave. W., 14th Fl.
Toronto, Ontario
M4V 1P5

Harwood, J.G.
Courtaulds Canada
1150 Montreal Rd.
Cornwall, Ontario
K6H 5S2

Hatton, J.
Ministry of the Environment
985 Adelaide St. S.
London, Ontario
N6E 1V3

Hayter, R.S.
SPI Canada
1262 Don Mills Rd., Ste. 104
Don Mills, Ontario
M3B 2W7

Hedley, C.
Corp. of the City of Cornwall
861 Second St. W., Box 877
Cornwall, Ontario
K6H 5T9

Heidbuurt, J.
Rothsay
R.R.#1
Moorefield, Ontario
N0G 2K0

Hellerman, P.
Township of Harwich
117 McGregor St.
Blenheim, Ontario
N0P 1A0

Henderson, D.
Tricil (Sarnia) Ltd.
89 The Queensway W.
Mississauga, Ontario
L5B 2V2

Hennin, G.P.
Tricil (Sarnia) Ltd.
R.R.#1
Corunna, Ontario
N0N 1G0

Hewings, J.
Ministry of the Environment
880 Bay St., 4th Fl.
Toronto, Ontario
M5S 2Z8

Heyink, H.
Ratcliffs Canada Ltd.
10537 Yonge St.
Richond Hill, Ontario
L4C 3C5

Hicks, J.
Cambrian College
1400 Barrydowne Rd.
Sudbury, Ontario
P3A 3V8

Higgins, B.
Tricil Environmental Management
P.O. Box 188T
Thorold, Ontario
L2V 3Y9

Hijazi, N.
Sanexen International Inc.
3027 Harvester Rd.
Burlington, Ontario
L7N 3G7

Hims, A.G.
Jagger Hims Ltd.
92 Davis Dr., Ste. 203
Newmarket, Ontario
L3Y 2N1

Hockett, W.
General Motors of Canada
Park Rd. South
Oshawa, Ontario
L1G 1K7

Hoffer, A.D.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Holdaway, A.
Township of Hope
P.O. Box 85
Port Hope, Ontario
L1A 3V9

Hollingshead, S.
Gartner Lee Ltd.
140 Renfrew Dr.
Markham, Ontario
L3R 6B3

Honnberger, R.
MacLaren Engineers Inc.
2235 Sheppard Ave. E.
Willowdale, Ontario
M2J 5A6

Hood, S.
PPG Canada Inc.
3730 Lakeshore Blvd. W.
Toronto, Ontario
M1P 2V9

Hoshowsky, D.
Metek Resource Recovery
P.O. Box 1584
Brantford, Ontario
N3T 5V6

Howard, D.J.
E.B. Eddy Forest Products
1 Station Rd.
Espanola, Ontario
P0P 1C0

Humphries, E.
Water & Pollution Control Mag
AIS Communications, Box 1060
Exeter, Ontario
N0M 1S0

Hunter, E.
Tricil (Sarnia) Ltd.
265 N. Front St., Ste. 502
Sarnia, Ontario
N7T 1X1

Ilyniak, M.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Ireland, D.R.
Ministry of the Environment
400 Clyde Rd., Box 219
Cambridge, Ontario
N1R 5T8

Isaac, A.
Taro Aggregates Inc.
341 1st Rd. West
Hamilton, Ontario
L8J 1W4

Isles, P.
Ministry of the Environment
65 St. Clair Ave. W., 7th Fl.
Toronto, Ontario
M4T 2Y3

Iszkula, S.
Stelco Inc.
100 King St. W.
Hamilton, Ontario
L8N 3T1

Iwonagos
Lepage
50 West Dr.
Bramalea, Ontario
L6T 4W1

Jackson, K.
D. Keith Jackson
26 Sagewood Dr.
Don Mills, Ontario
M3B 3G5

Jagger, D.E.
Jagger Hims Ltd.
92 Davis Dr., Ste. 203
Newmarket, Ontario
L3Y 2N1

Janse, J.
Ministry of the Environment
985 Adelaide St. S.
London, Ontario
N6E 1V3

Jarmain, L.
Victory Soya Mills
333 Lakeshore Blvd. E.
Toronto, Ontario
M5A 1C2

Jefferson, M.
Delcan Corporation
5233 Stanley Ave., Unit #1
Niagara Falls, Ontario
L2E 7C2

Johnston, E.
Tricil Environmental Management
63 Church St.
St. Catharines, Ontario
L2R 3C4

Jones, D.
TD Rooke Assoc.
105 Miranda Ave.
Toronto, Ontario
M6B 3W3

Jones, G.
National-Standard Co. of Cda.
20 Campbell Rd.
Guelph, Ontario
N1H 1C1

Jun, H.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Justrich, W.
Holderbank Consulting Ltd.
2310 Lakeshore Rd. W.
Mississauga, Ontario
L5J 1K2

Kawa, B.H.
City of Etobicoke
399 The West Mall, 4th Fl.
Etobicoke, Ontario
M9C 2Y2

Kawasaki, J.
Ministry of the Environment
7 Overlea Blvd., 4th Fl.
Toronto, Ontario
M4H 1A8

Kempling, J.C.
ESSO Petroleum Canada
55 St. Clair Ave. W.
Toronto, Ontario
M5W 2J8

Kerr, D.
Sanexen International Inc.
3027 Harvester Rd.
Burlington, Ontario
L7N 3G7

Kidman, L.R.
Ministry of Transportation
1201 Wilson Ave., 3rd Fl.
Downsview, Ontario
M3M 1J8

King, L.
Environment Canada
25 St. Clair Ave. E.
Toronto, Ontario
M4T 1M2

Kishbaugh, B.
Giffels Associates Ltd.
30 Internation Blvd.
Rexdale, Ontario
M9W 5P3

Klaassen, P.
Tricil Ltd.
470 Kenora Ave. N.
Hamilton, Ontario
L8E 3X8

Kmiec, R.R
Petro Canada Products
P.O. Box 520
Oakville, Ontario
L6J 5B5

Koeppe, B.J.
Baycoat
P.O. Box 624
Hamilton, Ontario
L8N 3K7

Koletar, F.L.
Work Wear Corporation of Canada Ltd.
17 Benton Rd.
Toronto, Ontario
M6M 3G3

Kruzins, A.E.
PBK Engineering Ltd.
1100 Walkers Line
Burlington, Ontario
L7N 2G3

Kuczynski, L.W.
Ontario Waste Management Corp.
2 Bloor St. W.
Toronto, Ontario
M4W 3E2

Kustan, E.
Marshall Maclin Monaghan Ltd.
275 Duncan Mills Rd.
Don Mills, Ontario
M3B 2Y1

Kutzeling, E.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Lahti, H.R.
Rosmar Consulting
49 Wellington St. E.
Toronto, Ontario
M5E 2C9

Lai, G.W.
Marshall Macklin Monaghan Ltd.
275 Duncan Mills Rd.
Don Mills, Ontario
M3B 2Y1

Laird, J.L.
Ontario Waste Management Corp.
2 Bloor St. W.
Toronto, Ontario
M4W 3E2

Lalonde, C.A.
Tricil Ltd.
89 The Queensway W.
Mississauga, Ontario
L5B 2V2

Langan, J.S.
Tricil (Sarnia) Ltd.
89 The Queensway W.
Missisauga, Ontario
L5B 2V2

Langford, T.
SWECO Canada Inc.
40 Titan Rd.
Etobicoke, Ontario
M8Z 2J8

LaRocque, M.
Tricil (Sarnia) Ltd.
265 N. Front St., Ste. 502
Sarnia, Ontario
N7T 7X1

Leblanc, M.L.
ACG Technology Ltd.
2175 Dunwin Dr. #5
Mississauaga, Ontario
L5L 1X2

Lee, M.
Tricil Ltd.
470 Kenora Ave. N.
Hamilton, Ontario
L8E 3X8

LeGrow, S.M.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Leishman, P.
Ontario Waste Management Corp.
845 Harrington Crt.
Burlington, Ontario
L7N 3P3

Leitch, A.
Region of Durham Works Dept.
105 Consumers Dr.
Whitby, Ontario
L1N 6A3

LePage, S.M.
Ministry of the Environment
199 Larch St.
Sudbury, Ontario
P3A 4G9

Lightowlers, W.R.
Ontario Waste Management Corp.
2 Bloor St. W., 11th Fl.
Toronto, Ontario
M4W 3E2

Lim, V.
Metropolitan Toronto Works Dept.
439 University Ave., 10th Fl.
Toronto, Ontario
M4C 1Y8

Linzon, S.
Ministry of the Environment
880 Bay St., 4th Fl.
Toronto, Ontario
M5S 1Z8

Lister, P.
Metropolitan Toronto Works Dept.
439 University Ave., 10th Fl.
Toronto, Ontario
M4C 1Y8

Lockington, N.
Dofasco Inc.
P.O. Box 2460
Hamilton, Ontario
L8N 3JS

Longland, M.J.
MacLarentech Inc.
2235 Sheppard Ave. W.
Willowdale, Ontario
M2J 5A6

McCormick, B.J.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

McIntyre, E.
Ministry of the Environment
135 St. Clair Ave. W., 14th Fl.
Toronto, Ontario
M4V 1P5

McManus, J.D.
Calgon Carbon Canada Inc.
6303 Airport Rd., Ste. 304
Mississauga, Ontario
L4V 1E3

McMillan, A.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

McMinn, S.
M.M. Dillon Ltd.
P.O. Box 426
London, Ontario
N6A 4W7

Mackay, G.
Browning-Ferris Industries Ltd.
161 Bridgeland Ave.
Toronto, Ontario
M6A 1Z1

Maclachlan, D.A.
Dow Chemical Canada Inc.
Box 1012
Sarnia, Ontario
N7T 7K7

Madill, K.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Magdalinski, D.
N.A.I.T.
11762-106 St.
Edmonton, Alberta
T5G 2R1

Makolin, R.J.
Kimberly-Clark of Canada Ltd.
Terrace Bay, Ontario
P0T 2W0

Mandzy, T.
Bristol Myers Manufacturing
99 Vanderhoof Ave.
Toronto, Ontario
M4G 2H6

Marcinkowski, J.
Devilbiss (Canada) Ltd.
Wood St., Box 3000
Barrie, Ontario
L4M 4V6

Marson, C.
Fiberglass Canada Inc.
P.O. Box 3049
Sarnia, Ontario
N7T 7X4

Martin, R.
Ford Motor co.
2900 Trenton St., Box 1650
Windsor, Ontario
N9A 7B2

Martindale, S.
Ministry of the Environment
119 King St. W., 12th Fl.
Hamilton, Ontario
L8N 3Z9

Marvan, I.
Dearborn Chemicals
P.O. Box 3060, Stn. A
Mississauga, Ontario
M9C 4V1

Matchett, D.
Steetley Industries Ltd.
P.O. Box 2029
Hamilton, Ontario
L8N 3S9

Mathe, C.B.
Ministry of the Environment
135 St. Clair Ave. W., 8th Fl.
Toronto, Ontario
M4V 1P5

Mattila, K.
PACE
1202-275 Slater St.
Ottawa, Ontario
K1P 5H9

Matys, V.
Gore & Storrie Ltd.
1670 Bayview Ave.
Toronto, Ontario
M4G 3C2

Mayberry, R.
Aiwley & Associates Ltd.
280 Pretty River Parkway
Collingwood, Ontario
L9Y 4J5

Merchant, A.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Miner, D.
Ontario Waste Management Corp.
2 Bloor St. W., 11th Fl.
Toronto, Ontario
M4W 3E2

Minor, J.
City of Scarborough
55 Town Centre Crt., Ste. 800
Scarborough, Ontario
M1P 4Y2

Misik, L.
Ministry of the Environment
7 Overlea Blvd., 4th Fl.
Toronto, Ontario
M4H 1A8

Morris, J.V.
MacLaren Plansearch Inc.
2235 Sheppard Ave. E.
Willowdale, Ontario
M2J 5A6

Mulder, W.R.
Chryslers Pillette Van Plant
121 Boardwalk Dr.
Amherstburg, Ontario
N9V 3C7

Munnoch, R.G.
Spruce Farms Power & Paper Co.
P.O. Box 100
Kapuskasing, Ontario
P5N 2Y2

Murray, P.
Gartner Lee Ltd.
140 Renfrew Dr.
Markham, Ontario
L3R 6B3

Nageleisen, M.
C-I-L Paints Inc.
1300 Castlefield Ave.
Toronto, Ontario
M6B 1G5

Nesbitt, B.
Tricil (Sarnia) Ltd.
R.#1
Corunna, Ontario
N0N 1G0

Neumann-uohler
Enviornmental Management Corp.
Ringst R.10
3014 Laatzen-Gleidingen
West Germany

Ng, W.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Nicolson, R.
Broadcast News Ltd.
36 King St. E.
Toronto, Ontario
M5C 2L9

Nixon, J.F.
Kilborn Ltd.
2200 Lakeshore Blvd. W.
Toronto, Ontario
M8V 1A4

Northfield, M.J.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Notten, E.A.
Buhler-Miag Can. Ltd.
59 Curlew Dr.
Don Mills, Ontario
M3A 2P8

Novisku, F.
Ont. Northland Transportation Commission
555 Oak St. E.
North Bay, Ontario
P1B 8L3

Nowina, R.F.
Tricil Ltd.
89 The Queensway W.
Mississauga, Ontario
L5B 2V2

O'Donohue, A.
City of Toronto
100 Queen St. W.
Toronto, Ontario
M5H 2N2

O'Hehir, K.
Kilborn Ltd.
2200 Lakeshore Blvd. W.
Toronto, Ontario
M8V 1A4

Okuhara, D.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Onderdonk, J.
Ministry of the Environment
40 St. Clair Ave. W., 7th Fl.
Toronto, Ontario
M4V 1M2

Osmond, D.
Gartner Lee Ltd.
140 Renfrew Dr.
Markham, Ontario
L3R 6B3

Owen, J.
IBM Canada Ltd.
Dept. 444, 844 Don Mills Rd.
North York, Ontario
M3C 1V7

Palmer, C.K.
Consoltex Inc.
St. George St., W., Box 730
Alexandria, Ontario
K0C 1A0

Pape, M.
Haldimand-Norfolk Regional Health Dept.
P.O. Box 247
Simcoe, Ontario
N3Y 4L1

Pasco, K.E.
Navistar International Corp.
508 Richmond St.
Chatham, Ontario
N7M 1R3

Paterson, W.E.
Kodak Canada Inc.
3500 Eglinton Ave. W.
Toronto, Ontario
M6M 1V3

Patterson, J.
Ministry of the Environment
135 St. Clair Ave. W.
Toronto, Ontario
M4V 1P5

Perron, V.
Philip Enterprises Inc.
52 Imperial St., Box 423, Stn. B
Hamilton, Ontario
L8L 7W2

Pestowka, M.
North American Plastics
P.O. Box 124
Wallaceburg, Ontario
N8A 4L5

Phillips, R.
City of Stratford
City Hall, 1 Wellington St.
Stratford, Ontario
N5A 2L1

Piech, R.
General Motors Canada
570 Glendale Ave.
St. Catharines, Ontario
L2R 7B3

Pioro, K.
Humber College
Humber College Blvd.
REXDALE, Ontario
M9W 5L7

Pirie, D.
Ministry of the Environment
7 Overlea Blvd., 4th Fl.
Toronto, Ontario
M4H 1A8

Pizans, T.
Tricil (Sarnia) Ltd.
R.#1
Corunna, Ontario
N0N 1G0

Pleasance, G.
Energy Pathways Inc.
1179 King St. W., Ste. 110
Toronto, Ontario
M6K 3C5

Pollock, A.
Dow Chemical Canada Inc.
Box 1012
Sarnia, Ontario
N7T 7K7

Pollock, D.
Deep Shaft Technology Inc.
90 Sheppard Ave. E.
North York, Ontario
M2N 6H2

Poppe, R.
Anachemia Solvents Ltd.
3549 Mavis Rd.
Mississauga, Ontario
L5C 1T7

Posen, G.S.
Ministry of the Environment
135 St. Clair Ave. W., 14th Fl.
Toronto, Ontario
M4V 1P5

Pudden, J.D.
County of Middlesex
50 King Street
London, Ontario
N6A 5L7

Quarshie, E.
Ontario Hydro
800 Kipling Ave.
Toronto, Ontario
M8Z 5S4

Quinn, H.W.
Dow Chemical Canada Inc.
Box 1012
Sarnia, Ontario
N7T 7K7

Radcliffe, S.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Rattle, C.
Institute of Environ. Research Inc.
81 Sheppard Ave. W., Ste. 201
Willowdale, Ontario
M2N 1M4

Ray, E.L.
Dofasco Inc.
P.O. Box 2460
Hamilton, Ontario
L8N 3J5

Rea, C.
Totten Sims Hubicki Assoc.
1500 Hopkins St.
Whitby, Ontario
L1N 2C3

Redhead, R.
Tricil Ltd.
89 The Queensway W.
Mississauga, Ontario
L5B 2V2

Reeves, J.A.
Ontario Hydro
700 University Ave., A8-E2
Toronto, Ontario
M5G 1X6

Reiser, J.
Kimberly-Clark of Canada Ltd.
Box 790
Huntsville, Ontario
P0A 1K0

Richmond, J.
Ontario Waste Management Corp.
2 Bloor St. W.
Toronto, Ontario
M4W 3E2

Rinne, R.J.
Ministry of the Environment
880 Bay St., 3rd Fl.
Toronto, Ontario
M5S 1Z8

Ristevski, P.
John Zink Canada
801 York Mills Rd., Ste. 201
Don Mills, Ontario
M3B 1X7

Roberts, C.A.
G.M.C.
1901 Eglinton Ave.
Scarborough, Ontario
M1L 2L8

Rocchi, J.
Retek Resource Recovery Inc.
P.O. Box 1584
Brantford, Ontario
N3T 5V6

Rocoski, G.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Rodricks, L.
PPG Canada Inc.
880 Avonhead Rd.
Mississauga, Ontario
L5J 2Z5

Rodrigues, D.
Metropolitan Toronto Works Dept.
439 University Ave., 10th Fl.
Toronto, Ontario
M4C 1Y8

Roechner, R.
Texaco Canada Inc.
Nanticoke Plant
Jarius, Ontario
N0A 1J0

Rothfuss, R.
Region of Peel
10 Peel Centre Dr.
Brampton, Ontario
L6T 4B9

Rouse, D.S.
Ontario Hydro
700 University Ave., H18-F22
Toronto, Ontario
M5G 1X6

Rowe, T.
James River-Marathon Ltd.
Postal Bag VR
Marathon, Ontario
P0T 2E0

Rowsell, J.A.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Sabo, J.E.
Ontario Waste Management Corp.
2 Bloor St. W.
Toronto, Ontario
M4W 3E2

Schram, D.
Proctor & Redfern Group
45 Green Belt Dr.
Don Mills, Ontario
M3C 3K3

Sciberras, J.
Canadian Environmental Auditors Inc.
R.R.#1
Gilford, Ontario
L0L 1R0

Sears, S.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Seguin, B.
Comunaute Urbaine de Montreal
451 Antoine Forestier Vimont
Laval, Quebec
H7M 4G1

Shannon, E.E.
Canviro Consultants
180 King St. S., Ste. 600
Waterloo, Ontario
N2J 1P8

Shaw, J.
Mosaic Chemical Corporation
5369 Maingate Dr.
Mississauga, Ontario
L4W 1G6

Shikaze, K.
Environment Canada
25 St. Clair Ave. E., 7th Fl.
Toronto, Ontario
M4T 1M2

Sibul, U.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Sigrist, S.
Kodak Canada Inc.
3500 Eglinton Ave. W.
Toronto, Ontario
M6M 1V3

Simmie, R.
Tricil Ltd.
89 The Queensway W.
Mississauga, Ontario
L5B 2V2

Slivar, R.
Tricil Environmental Management
551 Avonhead Rd.
Mississauga, Ontario
L5J 4B1

Smale, J.G.
Du Pont Canada Inc.
P.O. Box 2200, Streetsville
Mississauga, Ontario
L5M 2H3

Smith, B.
Walker Brothers Quarries Ltd.
P.O. Box 100
Thorold, Ontario
L2V 3Y8

Smith, P.
Stelco Steel
Utilities Dept., Box 2030
Hamilton, Ontario
L8N 3T1

Smith, P.D
Stelco Steel
Hilton Works Eng., Box 2030
Hamilton, Ontario
L8N 3T1

Smyth, R.
A Johnson (Canada) Inc.
9050 Ryan Ave.
Montreal, Quebec
H9P 2M8

Sonneveld, J.
City of Chatham W.P.C.P.
P.O. Box 640
Chatham, Ontario
N7M 5K8

Spersrud, D.
Ford Motor Co., American Rd.
Box 1899, WHQ Room 640
Dearborn, Michigan
48121

Spira, G.H.
Chemical Waste Management
Ste. 453 Caborundum Centre
Niagara Falls, NY
14303

Steinback, B.J.
Abitibi-Price Inc.
Sheridan Park
Mississauga, Ontario
L5K 1A9

Stephens, A.
Ministry of the Environment
250 Windsor Ave.
Windsor, Ontario
N9A 6V9

Stephens, H.
Packaging Association of Canada
111 Merton St., Ste. 201
Toronto, Ontario
M4S 3A7

Sterling, T.
Corpus Info Services
1450 Don Mills Rd.
Don Mills, Ontario
M3B 2X7

Stevens, D.
Proctor & Redfern Group
45 Green Belt Dr.
Don Mills, Ontario
M3C 3K3

Stevens, T.G.
Nabisco Brands Ltd.
1101 Walkers Line
Burlington, Ontario
L7N 2G4

Stewart, J.W.
Chem-King Inc.
125 Ferndale Dr.
Barrie, Ontario
L4M 4S4

Stewart, R.C.
Ministry of the Environment
Box 2112, 119 King St. W., 12th Fl.
Hamilton, Ontario
L8N 3Z9

Stoner, N.
Durham West
2 Randall Dr., Office 1
Ajax, Ontario
L1S 6E6

Storin, T.
Kimberly-Clark
10 Disco Rd.
Rexdale, Ontario
M9W 1M2

Strang, P.
PPG Canada Inc.
3730 Lakeshore Blvd. W.
Toronto, Ontario
M1P 2V9

Sudbury, M.P.
Falconbridge Ltd.
40 Commerce Crt. W.
Toronto, Ontario
M5L 1B4

Suppelsa, D.G.
Region of Durham Works Dept.
105 Consumers Dr.
Whitby, Ontario
L1N 6A3

Sutherland, A.
Energy Pathways Inc.
1179 King St. W., Ste. 110
Toronto, Ontario
M6K 3C5

Swinwood, J.F.
Radiochemical Co.
Box 13500
Kanata, Ontario
K2K 1X8

Tanaka, B.
Dofasco Inc., Env. Control Dept.
P.O. Box 2460, Stn. A.
Hamilton, Ontario
L8N 3J5

Teleki, G.C.
Delcan Corporation
133 Wynford Dr.
Toronto, Ontario
M3C 1K1

Temple, J.
The Toronto Star
One Yonge St.
Toronto, Ontario
M5E 1E5

Terluk, V.
Hamilton-Wentworth Region
71 Main St. W.
Hamilton, Ontario
L8N 3T4

Theurer, H.
Rothsay
R.R.#1
Moorefield, Ontario
N0G 2K0

Tilford, J.
Ford Motor Co.
Highway #4, Box 2005
St. Thomas, Ontario
N5P 3W1

Tolson, D.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Tomarin, J.
Ministry of the Environment
40 St. Clair Ave. W., 6th Fl.
Toronto, Ontario
M4V 1M2

Toporowski, F.
DeVilbiss (Canada) Ltd.
P.O. Box 3000
Barrie, Ontario
L4M 4V6

Torossian, H.
DOMTAR Inc.
385 de Maisonneuve Blvd. W.
Montreal, Quebec
H3A 1L6

Towns, C.
Dow Chemical Canada Inc.
122 Arrow Rd.
Weston, Ontario
M9M 2H2

Tristani, R.
Stelco Inc.
100 King St. W., Box 2030
Hamilton, Ontario
L8N 3T1

Tse, W.
Waste Management Br., MOE
40 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1M2

Tseung, T.
Environment Canada
25 St. Clair Ave. E.
Toronto, Ontario
M4T 1M2

Uffen, N.
Eaglebrook Environmental Corp.
2650 Royal Windsor Dr.
Mississauga, Ontario
L5J 1K7

Valade, T.
Environ. Management Corp.
2128 River Rd.
London, Ontario
N6A 4C3

Van Dam, W.
Ford Motor Co.
Highway 4, Box 2005
St. Thomas, Ontario
N5P 3W1

Van Egmond, J.
Egmond Geospheric Assoc.
174 Poplar
Acton, Ontario
L7J 2E4

Van Veem, L.
Tricil (Sarnia) Ltd.
R.R.#1
Corunna, Ontario
N0N 1G0

Varangu, L.
Ont. Waste Exchange, Ont. Rsch. Fnd.
Sheridan Park Research Com.
Mississauga, Ontario
L5K 1B3

Veel, A.E.
Ontario Waste Management Corp.
2 Bloor St. W.
Toronto, Ontario
M4W 3E2

Vijh, G.R.
General Motors of Canada Ltd.
570 Glendale Ave.
St. Catharines, Ontario
L2R 7B3

Vismantis, E.
Region of Peel
10 Peel Centre Dr.
Brampton, Ontario
L6T 4B9

Voss, F.
DeVilbiss (Canada) Ltd.
P.O. Box 3000
Barrie, Ontario
L4M 4V6

Walden, D.
Ministry of the Environment
135 St. Clair Ave. W., 5th Fl.
Toronto, Ontario
M4V 1P5

Waldinsperger, E.
CN Rail
277 Front St. W., Ste. 405
Toronto, Ontario
M5V 2X7

Walker, N.W.
Woodington Systems Inc.
P.O. Box 100
Thorold, Ontario
L2V 3Y8

Wastle, B.
Dow Chemical Canada Inc.
1086 Modeland Rd.
Sarnia, Ontario
N7T 7K7

Watters, D.B.
Ministry of the Environment
135 St. Clair Ave. W., 11th Fl.
Toronto, Ontario
M4V 1P5

Weaver, M.K.
Ministry of Transportation
1201 Wilson Ave.
Downsview, Ontario
M3M 1J8

Weisman, B.
SOPHOS Inc.
28 Gordon Rowe Cr.
Richmond Hill, Ontario
L4C 8R8

Wells, W.
M.M. Dillon Ltd.
47 Sheppard Ave. E.
Willowdale, Ontario
M2N 6H5

Werezak, G.
Dow Chemical Canada Inc.
Box 1012
Sarnia, Ontario
N7T 7K7

Westerby, G.
Gartner Lee Ltd.
140 Renfrew Dr.
Markham, Ontario
L3R 6B3

Westlake, G.F.
Ministry of the Environment
125 Resources Rd.
Rexdale, Ontario
M9W 5L1

Wheeler, B.L.
MacLaren Engineers Inc.
320 Adelaide St. S.
London, Ontario
N5Z 3L2

Whitehead, R.
Enviroclean
320 Adelaide St. S.
London, Ontario
N5Z 3L2

Wiber, M.A.
Noranda Inc.
4 King St. W.
Toronto, Ontario
M5H 3X2

Wile, I.
Ministry of the Environment
135 St. Clair Ave. W.
Toronto, Ontario
M4V 1P5

Williams, R.A.
Tricil (Sarnia) Ltd.
R.#1
Corunna, Ontario
N0N 1G0

Wismer, D.A.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Witko, C.
Hatch Associates Ltd.
21 St. Clair Ave. E.
Toronto, Ontario
M4T 1L9

Wolfe, L.
Quadra Planning Consultants Ltd.
661 Barnham Rd.
West Vancouver, BC
V7S 1T6

Wong, T.S.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Wowk, K.H.
Ministry of the Environment
40 St. Clair Ave. W.
Toronto, Ontario
M4V 1M2

Wulff, K.L.
Chemical Surplus Ltd.
Ste. 919, 21 Dale Ave.
Toronto, Ontario
M4W 1K3

Yatabe, M.
Gore & Storrie Ltd.
1670 Bayview Ave.
Toronto, Ontario
M4G 3C2

Yates, D.
General Motors of Canada Ltd.
570 Glendale Ave.
St. Catharines, Ontario
L2R 7B3

Yee, L.Y.
Gore & Storrie Ltd.
1670 Bayview Ave.
Toronto, Ontario
M4G 3C2

Yee, M.
C-I-L
1300 Castlefield Ave.
Toronto, Ontario
M6B 1G5

Young, R.E.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6

Yu, M.
Ontario Hydro
700 University Ave.
Toronto, Ontario
M5G 1X6